G-859 MINING MAG Cesium Vapor Magnetometer

Operation Manual

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EC DECLARATION OF CONFORMITY

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declare under our sole responsibility that our portable magnetometers, models G-859 to which this declaration relates are in conformity with the following standards:

EN61010-1 :1993/A2: 1995

per the provisions of the **Low Voltage Directive** ***73/231EEC*** of 19 February 1973 as Amended by ***93/68/EEC, Article 13*** of 22 July 1993 and,

EN 55022: 1995, EN50082-2 : 1995, ENV 50140: 1994, ENV 50141 :1994, EN 61000-4-2: 1995, EN 61000-4-4: 1995

per the provisions of the **Electromagnetic Compatibility Directive** ***8913361EEC*** of May 1989 as Amended by ***92131/EEC*** of 28 April 1992 and *93/68-EEC, Article 5* of 22 July 1993.

The Technical documentation required by Annex IV(3) of the Low Voltage Directive is maintained by Christopher Leech of Geometrics Europe (address below).

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Warning

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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Chapter 1: Introduction

Overview

The model G-859 Mining Mag is a professional quality magnetic mapping tool offering exceptional speed and efficiency. The system in configured for use in the geological context, for producing detailed magnetic maps for exploration of minerals, oil/gas, diamonds and man-made structures. Data is stored in non-volatile memory for playback review and downloading into a host PC. The system includes a comprehensive software package to download, edit and interpolate magnetic data into 2D or 3D contour-ready formats. Hard copy annotated color maps can be produced within minutes after data transfer to the base computer.

The G-859 includes three unique features, each intended to assist the collection of magnetic data. First, the system lets you visualize the survey area beforehand in X-Y space, entering in the desired survey corner location points. Second, it lets you review your locations and your data during the survey. The system presents a "Quick Look" to the operator of up to 5 stacked survey profiles for quality control purposes. Finally, the unit allows you to edit X-Y position and magnetometer data, both in the field and in later processing.

Figure 1 G-859 with sensor at 45 deg

Applications

The G-859 Mining Mag is primarily used for exploration programs for minerals, oil, gas, diamonds and geologic survey. It can also be used to locate waste dumps, buried drums or other underground storage containers; to find pipelines, well-heads and other utilities; to study geological structures and faults. The fast response of the instrument means that the data may be taken at a brisk walking pace which efficiently covers four to ten times as much ground per hour as non-cesium magnetometers. The high sensitivity means that many potential targets which would have been missed with other techniques will stand out clearly and unambiguously.

Features

The G-859 has been designed to greatly simplify magnetic surveying. All of its features are intended to speed up the surveying process and reduce the possibility of mistakes. Toward that end, the following features have been incorporated into the G-859:

- Continuous surveying, where the unit automatically records data at a user-selectable rate, up to 5 readings per second (Note: Newmont rate is 10 Hz).
- Integrated NovAtel Smart Antenna™ GPS system is preconfigured, Lat/Long data recorded simultaneously with the magnetic data. Used to produce a located survey map and exportable interpolated data set using the supplied MagMap2000 program.
- Audible tone indicating goodness of GPS fix
- Discrete surveying option where the unit takes a reading upon an operator key-press.
- Four modes of operation: search mode, for performing a random search for anomalies or system test; simple survey, for a simplified method of operation with Line and Station marking; mapped survey, for the full capability of defining X-Y location and tracking position as readings are taken; and base station, for collecting data to be used for diurnal corrections.
- Real-time analog waterfall display of the current magnetometer reading.
- Up to five separate surveys may be stored independently for up to 6 to 8 hours of recorded data with GPS.
- Map display showing the X-Y survey area, with readings plotted in the correct X-Y locations.
- Data profile displays, allowing previous data to be reviewed on line by line basis.
- Data editing capability, where data may be deleted and retaken.
- Downloading of data in compressed format to a host PC.
- MagMap2000 software for editing data positions, GPS positions, doing diurnal corrections, filtering, de-spiking, de-striping and drawing profiles and contour maps.
- Writing a out a file for plotting profiles and surface contours with Geometrics or 3rd party software, such as MagPick, Surfer or GeoSoft.
- Audible tones indicating the field change over the local target, warning of non-valid data, indicating that data was taken and stored, and that location keys have been pressed.
- Storage capacity for more than 250,000 readings and positions, each recorded with the time of the event and position, including externally logged GPS positions.
- Logging of user-defined field notes.

Modes of Operation

Here we present an overview of the modes of operation, along with their advantages and when each should be used.

GPS Survey Mode

Used in conjunction with either Simple Survey or Mapped Survey mode described below, the magnetometer receives GPS transmissions at regular intervals (typically every 1 second) and stores those positions along with the magnetometer data acquired at a 1, 2 or 5 Hz rate. When downloaded into the supplied MagMap2000 program, the GPS positions are interpolated so that each magnetometer reading is assigned a GPS position. GPS data reception is signaled by a blinking RS-232 display box.

Search Mode

In Search mode, the magnetometer operates normally, displaying an analog oscilloscope-like trace, with an audible sound whose pitch indicates changes in the field reading (the "woowee" indicator). However, data is not stored in memory. This is useful for manually identifying anomaly locations, much as with a metal detector. It is also useful to check for proper sensor operation, ambient magnetic noise and the magnetic cleanliness of survey operator accessories such as shoes, belt buckles, keys etc.

Simple Survey Mode

This is the recommended mode for use with the Novatel GPS. In simple survey mode, the unit keeps track of MARK (start line, and waypoints) and END LINE (end of line) key presses, and the direction of each line. This allows a full and complete survey. Later, after downloading the data into the PC, the MagMap2000 program will attach an x and y coordinate to each reading.

Simple survey mode allows the simplest operation of the G-859, enabling the operator to easily assign X-Y positions in the supplied MagMap2000 software. You must manually keep track of where you are taking data, and enter this information into the host software to locate the readings.

Simple survey mode lends itself to interfacing to the integrated Novatel GPS system which transmits position data as a $GPGGA string to the G-859 Console. MagMap2000 allows positioning of the data in either rectilinear X-Y and GPS mode.

Mapped Survey Mode

Mapped survey allows you to visualize the survey area more completely than in simple survey mode and move around within the area in a non-contiguous fashion. Using the arrow keys, you may position the cursor anywhere within the map and acquire data. Default cursor movements are programmed into the unit, so if you follow a normal path across the survey area, you may simply press the MARK and END LINE keys as if you were doing a simple survey.

This method allows the easiest operation of the PC host software. You must enter more information into the G-859, however. This mode will track your X-Y position for you automatically, assuming you are following a simple path, while also allowing you to change your position manually, when, for example, you reach an obstruction and wish to start again on the other side.

Base Station Mode

In base station mode, the unit will not keep track of changes in position. This is most useful when the unit is being used to collect data for diurnal correction. Both data and the time of the readings are stored in internal memory.

In addition, this mode supports a real-time transfer of data out of the RS-232 port as it is being acquired. This is useful if you are using another PC to collect and process the data, for instance, when using the G-859 from a mobile platform. Of course, you may also store the data inside the G-859, with or without real-time transfer.

Magnetic Surveying Checklist

Here we give a quick checklist for performing a magnetic survey. Please see Appendix 1 if you are unfamiliar with magnetic surveying. Subsequent chapters will explain in detail the operation of the G-859 during the survey and of use with the Novatel GPS (See Chapter 9). GPS data is automatically stored and later interpolated to provide a position for each magnetometer reading. The following sections refer to operation in X-Y positioning mode only. X-Y data positioning can be used as a backup to GPS positioning.

1. Setting up the survey grid

- Designate an individual to be responsible for making a sketch of the survey site, with notes and comments on all relevant objects such as power lines, fences, pipes, and surface debris.
- Establish a base line, which will provide the start or end points for all profile lines. Designate the left hand corner of the base line to be (0,0) for the X and Y axes. Note that the survey lines can run in any direction, but if a choice exists, the preferred direction would be North and South.
- Using the smallest search target size, determine the separation of the profile lines. For small targets such as a one pound ferrous mass with worst case shape and orientation, lines spaced 2 meters apart is a good initial choice. For mining and geologic surveys, line spacing may be 50m to 100m or more.
- Place non-magnetic, brightly colored markers at the start and stop of each profile. If the lines are long or require irregular walking speeds, place a marker at regular intervals (perhaps each 20 or 50 meters) along the profile. These will become fiducial or waypoint entries in the data stream.
- If the survey is to be broken into separate but adjacent areas, it will help you to stitch the sections together if there is at least one profile line of overlap. Also insure that the profiles extend beyond the actual survey boundary by at least 2 or 3 times the estimated target depth.
- Locate the survey area corners and reference them to other surface objects. If the site will be relocated in the future, it may be useful to permanently mark the corners with an iron stake (re-bar) driven down to ground level. Note that these corner stakes are

the only magnetic objects that are used on the entire survey site. Flags, cones, stakes and other markers must be carefully inspected to be non-magnetic.

2. Turn on and warm up the G-859 (about 2 minutes), using the procedure described in Chapter 2. Select the Search Mode, and adjust the sensor for the proper operating orientation, i.e. there should be continuous signal and correct instrument operation in all directions of the survey profiles. The program CSAZ will help to determine the best sensor orientation to avoid dead zones. Turn on the GPS if not already on. There is a switch on the battery compartment to power up the GPS. Remember to turn this off when the GPS is not in use.

3. Demagnetize the magnetometer operator. Using the G-859 in the Search Mode, insure that the operator does not contribute an error greater than 1 nT in any direction. (Refer to the Applications Manual, chapter 4 for a fast, simple, "magnetic swing" procedure that will measure the operator's magnetic cleanliness.) Pay particular attention to the operator shoes, eye glasses, and the removal of rings, keys, belt buckles, and all pocket items. Only a small amount of magnetic material is needed to seriously distort the magnetic data.

4. Select a survey "Test Profile" line. This profile should be run in each direction at the start and end of each survey day as a check of data repeatability and quality. It is an excellent check of proper system operation and may be useful as "proof of operation" to the end user.

5. Perform the data acquisition for all survey profiles and record the direction of each profile on the survey sketch map. Also record the start and end locations and the direction of the first and last survey profiles for each survey day. This may be duplication of effort, but is independent of the data logged in the instrument and may be very helpful in editing the data during processing.

6. During the course of the survey it is important that the operator has adequate support in finding and staying on the line. However, if the operator is disrupted during data acquisition, the G-859 easily allows data to be deleted and/or retaken. The G-859 has been designed to reduce mistakes and save money.

7. Finally, at the end of the survey, download the data to your host PC using the RS-232 download cable. Edit the positions if necessary, smooth GPS positions as required and plot the data in profile or contour map in MagMap2000. MagMap2000 also provides routines for

- Spike editing. Included a dropout removal tool and a "range despike" that removes any data spikes that exceed a graphical threshold drawn as a box around the profile data
- Spline filtering. A low pass or high pass adjustable filter is available to remove unwanted frequencies from the data. This enables the operator to remove surface clutter from geological map data for instance.
- De-Striping. This routine provides the ability to take a grid of data and greatly reduce heading error offsets sometimes seen when data collected in opposite directions on subsequent lines is contoured resulting in "corrugated" or striped data result.
- Diurnal corrections. This requires a secondary G-856 or G-859 magnetometer used as base station. It is critical that the clocks be synchronized in the two field instruments prior to survey, both date and time. Files from the roving and base station magnetometers are both loaded into MagMap2000 and the diurnal correction is applied on Export of the data to *.dat or *.xyz format (Surfer, MagPick or Geosoft formats). The *.dat file may be reimported into MagMap2000 to show the corrected data profiles.

Chapter 2: Assembly and Set Up

This chapter gives an overview of the entire surveying process. It will describe how to set up the instrument, operate in GPS / *Simple Survey* mode, and download the data into the PC for analysis. Please read Chapter 3 as soon as you can to find out more about your G-859 magnetometer.

Unpacking your G-859

The instrument is shipped in a rugged wheeled reusable shipping container, with each element carefully packed in an overlapping padded wrap or pouch. Unlock the case and fold out the padded packing wrap by pulling apart the Velcro as shown in Figure 2.

Figure 2 Shipping Container with Wrap

Carefully remove the console and the pack frame (backpack) with the GPS antenna and sensor mounted on their respective masts. Note that the second battery, charger, charger and data cables are in pouches in the front of the case. Inspect the parts list below and verify all components are in the shipping box.

Figure 3 Remove Console from Pouch, lift pack frame from the padding

The tables below show the items that should be included.

Part Number	Name	Description
	Console	Main magnetometer console, containing electronics, keypad, and display. Attached to pack frame
	Battery in pouch (2 included)	Battery pouch and mounting box for easy carrying of the system batteries.
	Novatel SmartAntenna GPS	GPS is cabled with the battery pack and data logging console. Attached to the pack frame GPS mount
	GPS Cable Wrap	Use to secure GPS cable to mounting staff
	GPS Antenna Shroud	Padded pouch for GPS for protection
	Pack Frame	Back pack provides integrated cesium magnetometer and Novatel GPS. Provides mounting for GPS SmartAntenna, cesium sensor, batteries, 859 Logging Console and all cabling
	Sensor	Measures the magnetic field. Mounted on the staff associated with the pack frame sensor mount
	Sensor clamps	Hold the sensor to the pack frame sensor mount
	Serial cable	Provides data transmission from G-859 to the PC
	Battery Charger	Recharges battery pack in about 6 hours
	Adapter plug kit	Adapts charger to various AC power standards
	Fuse assembly	Extra fuses for battery cable fuse
	Application manual	Included on Magnetometer CD along with MagMap2000 and MagPick. Describes principles of magnetic surveying
	Operation manual	This document
	MagMap2000 PC software	Used to download data to host PC, modify positions, and write output files.
	Shipping case	For storage and shipping of the G-859 pack frame, console, sensor, batteries, charger and other accessories

Items included in G-859 Ship Kit.

Assembly of the Pack Frame components

Lift the Pack Frame and console free of the shipping container and set them on a table or clean surface. First, make sure the power cable is attached to the Console. It may have been removed during shipment. See figure 4 below

Figure 4 Insert Power Connector to G-859 Console

Figure 5 Store Console on pack frame for transport

Stowing the G-859 Console on the Pack Frame

For setup and transport, it will be convenient to slide the 859 console into the space above the battery box. Once the console is seated, tighten the vertical strap provided to keep it securely in place.

Cesium Sensor Adjustments

Next we will adjust the cesium sensor position. Note that the sensor may be mounted vertically, at 45º to the vertical and horizontally. Basically once you select the proper orientation for your area it will always mount in that manner. We suggest that you install and use CSAZ, a companion program on the Magnetometer CD that shows you how you should mount your sensor for any location on the globe. Suffice it to say that in the far northern and southern latitudes, the sensor will be mounted at 45º, for the mid latitude zones including as far south as Northern S. America you will mount the sensor vertically. In a narrow band about the earth's magnetic equator (not zero latitude necessarily) you will mount the sensor at 45º or horizontally with the top of the sensor tilted either North or South as you walk the survey line. See CSAZ for more information

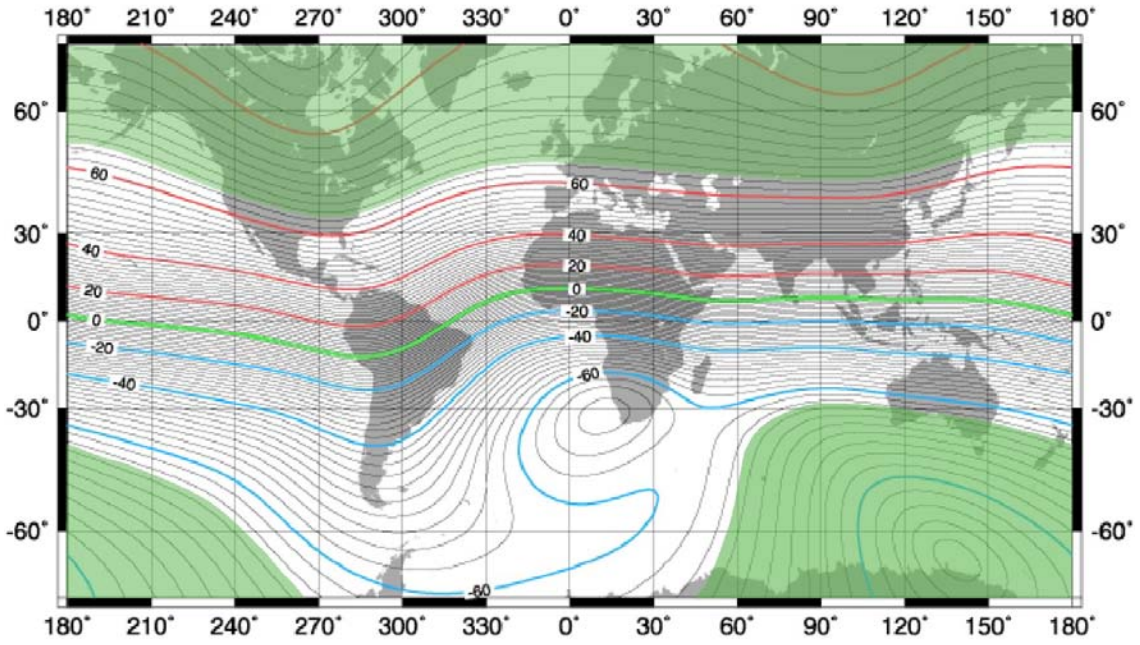


Figure 6 World map showing highlighted Vertical Magnetic field zone for 45 deg sensor mounting

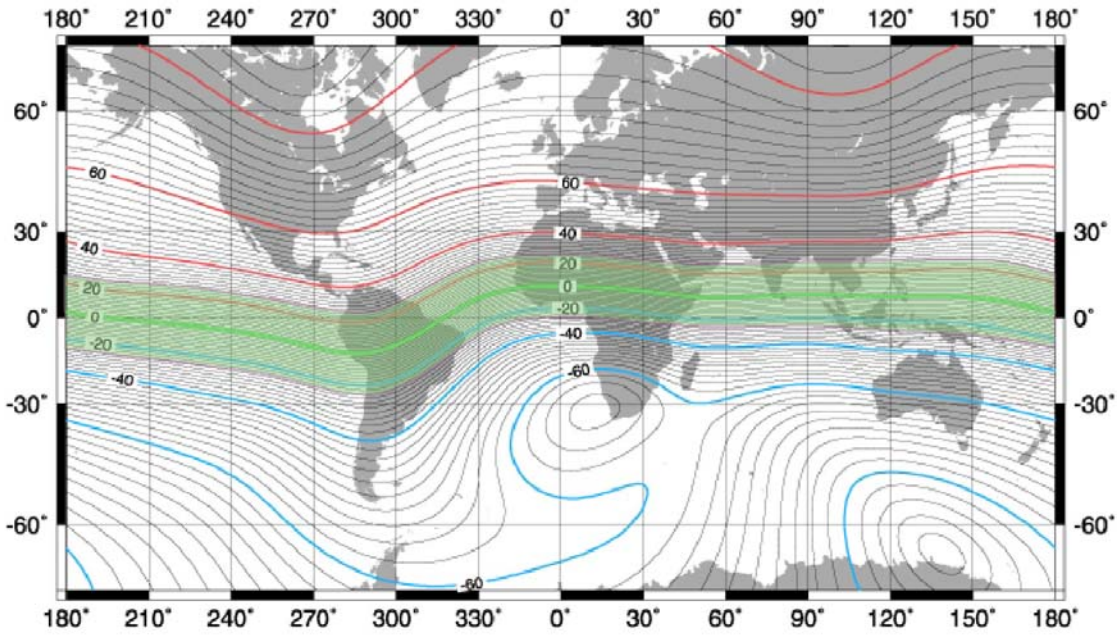


Figure 7 World map showing highlighted Horizontal Magnetic field zone for 45 or 90 deg mounting

Loosen the Sensor Clamp sensor knurled screw and push the sensor up until the bottom of the sensor is even with the clamp ring. Hand tighten screw. See picture below. Then remove the clamp screw holding the sensor clamp to the sensor mast. Rotate the sensor clamp 180º

Figure 9 Sensor Body Clamp

Figure 9 Sensor Mast Clamp

so that it extends laterally out to the right side of the pack frame as shown in Figure 9 and reinsert the sensor clamp screw and tighten. This is the proper installation for vertical orientation of the sensor.

To orient the sensor for 45º or for horizontal operation, remove the Mast Clamp screw and place the clamp on the mast at 45º or 90º using the appropriate mast channel. See Figure 10 for examples of 45º and 90º installation.

Figure 11 Remove Mast Clamp and swivel to right of pack frame

Figure 11 Sensor mounted at 45 and 90 deg

Installing the NovAtel Smart Antenna GPS™ mast

The GPS antenna mast has been mounted inside the pack frame for shipping. You must remove the antenna mast, rotate the clamp to the left to make the greatest lateral distance from the sensor mount, ensure the cable protection coverings are installed and then mount the antenna mast vertically on the left side of the pack frame.

Begin by loosening the antenna mast clamp screw and removing the antenna mast from the clamp as shown in Figure 12

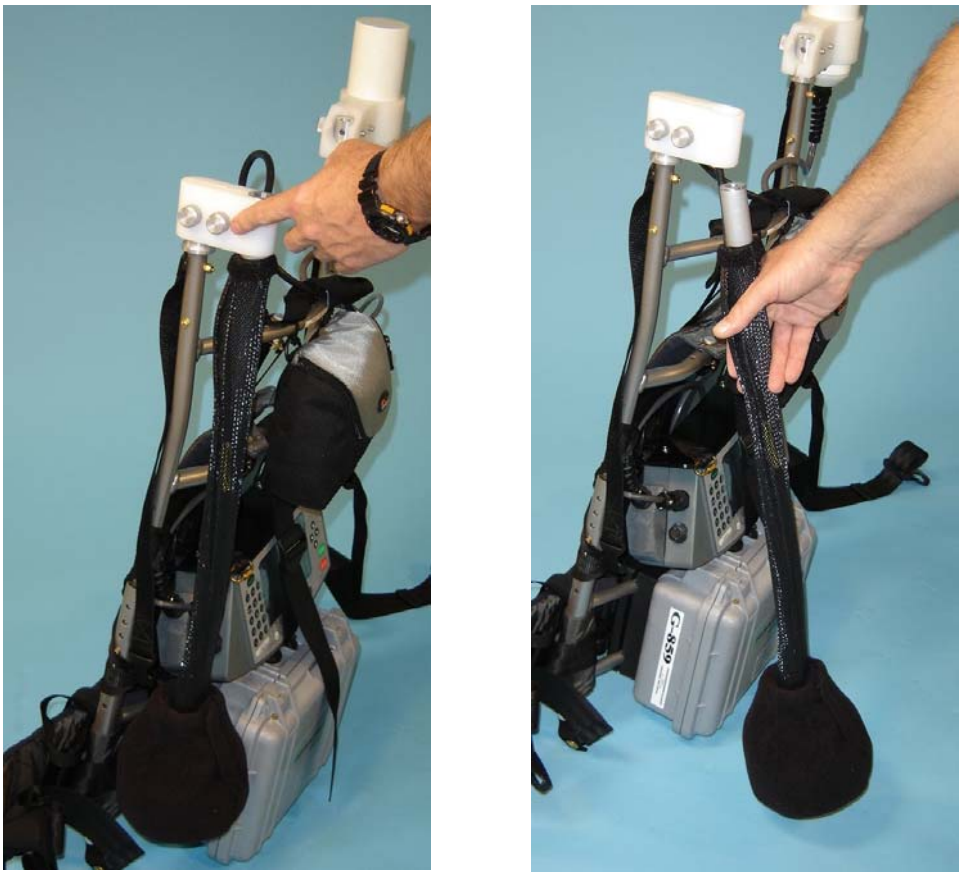


Figure 12 Remove Antenna mast from Pack Frame

Make sure the GPS cable wrap is securely fitted around the cable to prevent branches and brush from hooking on the GPS cable assembly. (Note: appearance of wrap material may vary). For a similar reason, make sure the Novatel SmartAntenna GPS antenna is covered with the black antenna shroud to protect the antenna and cable mount from branches and brush. See pictures below.

Figure 13 Insert Antenna Mast into clamp

Figure 14 Completed Pack Frame ready for transport

The finished pack frame assembly is shown at the left in Figure 14. Note that the sensor and GPS mast are separated by the greatest lateral distance and that the antenna mast and sensor have their associated coverings. The cables may be further secured to the pack frame with small Velcro straps included in the shipping container.

Additional cable is provides in the cable bag should you need it. Effort should be made to limit the amount of exposed cable and subsequent snagging on branches which will occur during normal survey operations. Stow as much cable in the cable bag as possible.

The assembled pack frame is now ready for battery installation or battery replacement. The following section describes this process. After battery installation the system is ready for transport to the survey start point or for mounting on the survey operator.

Battery Installation

The battery packs were fully charged before leaving the factory, but depending on storage time, they may need to be recharged. The system may come with the one of the battery packs pre-installed in the pack frame box. In this case you will check the voltage of the battery pack using the G-859 console battery meter (you must turn on the G-859 to see the meter reading). Recharge time is approximately 6 to 8 hours per battery. The battery may be recharged in the pack frame battery box using the standard charger cable.

Locate one of the special 24 VDC magnetically compensated battery packs is its carrying pouch. Lift the battery by its carrying strap and set it next to the pack frame. You will need to lean the pack frame assembly against a vertical support (tree or vehicle) while you install the battery. Open the G-859 battery compartment and set the battery on the open cover.

Inspect the connectors in the battery compartment and on the battery and note that they are keyed so that they can mate in only one orientation. Line up the keyed sections and firmly push the connector together. There is no locking sleeve, the friction of the rubber components will hold the connector together.

Lift the battery pack and slide it into the battery compartment, taking care to position the connector above the battery pack. When the battery is seated in the compartment, close and lock the battery box with the snap clasps.

Batteries will power the G-859 and Novatel GPS for between 5 and 7 hours depending on operating temperature. Cold temperatures will decrease battery capacity and increase magnetometer current requirements. Note that in very cold areas, the cesium sensor should be enclosed in an insulating jacket to keep heat loss to a minimum and extend battery life.

There is a small toggle switch on the top of the battery box for turning on the GPS. Remember to turn this switch on prior to mounting the pack frame on the operator! **NOTE** To best maintain battery life, you should periodically charge the batteries (about every 4 months) if the unit is not in use.

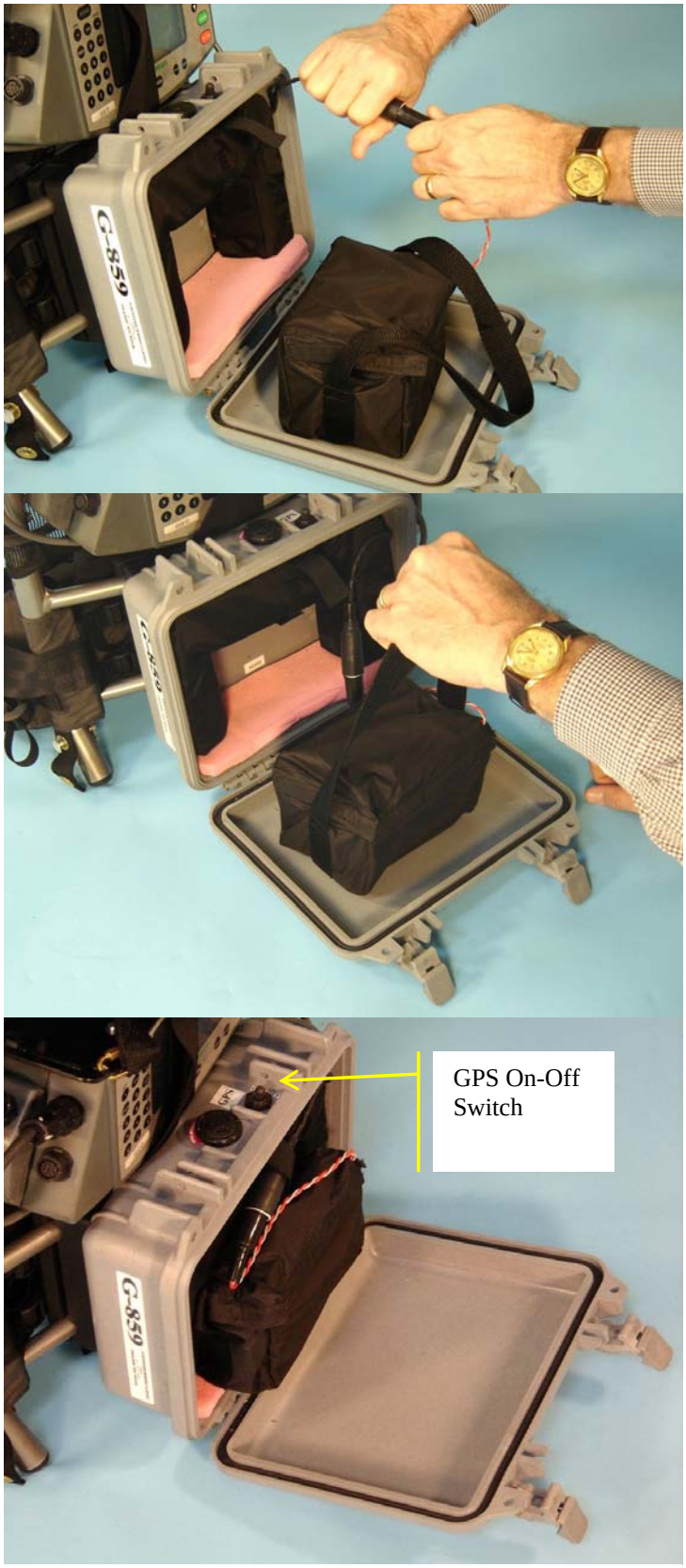


Figure 15 Battery Installation procedure

Adjusting the Pack Frame

The first time the pack frame is assembled and used, it will be necessary to adjust it for the individual user. This may require a second person to observe and make adjustments to the fit while the system is worn by the survey crew member. The pack frame is a professional grade frame with several different strap adjustments available. In addition, the frame itself is made of telescoping vertical poles that allow the frame to be extended or compressed for different sized individuals.

The pack frame commercial hardware has been replaced with brass and aluminum parts, removing all ferromagnetic components to keep the system magnetic self-signature to a minimum, thus reducing heading error and other platform noise. Never replace hardware with untested bolts, nuts or rings. Always test the hardware first by turning on the magnetometer and moving the hardware under test near the sensor. Typical goals are to have less than 0.5nT effect at 2 feet (0.6m) from the sensor.

The brass bolts on the vertical frame poles should be adjusted such that the shoulder straps start approximately 3 inches (7 cm) below and behind the shoulder. If the straps are too high the weight of the pack will not be on the shoulders, remove the brass bolts and shorten the vertical poles. If the straps are too low the straps will not adjust in the front. Then lengthen the vertical poles. See photo below for brass scew location.

If you need to extend or compress the pack frame, remove all 4 brass bolts and nuts and slide the pack frame tubing into or out of the mating tubing to get the proper height. You may have to loosen the back support webbing to get to the screws and to reposition the tubing. Reassemble the pack frame using the same bolts and nuts. Remember that any hardware not supplied by Geometrics is possibly contaminated with ferrous materials and can cause magnetic contamination.

Figure 16 Brass Bolts for Frame Adjustment

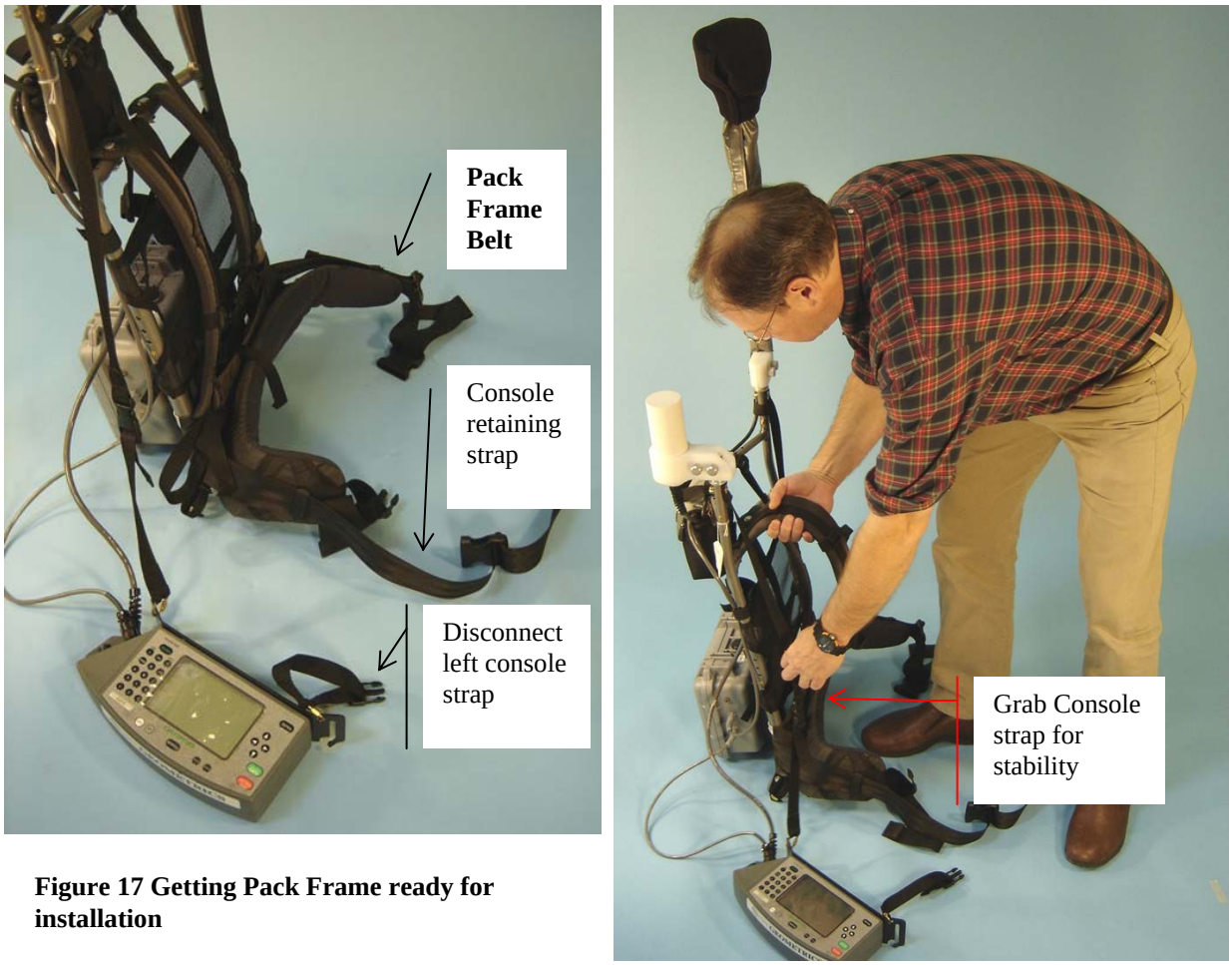


Figure 17 Getting Pack Frame ready for installation

Putting on the Pack Frame

Putting on the pack frame may be most easily performed on a raised surface such as the back of a pickup truck or table. To put on the pack frame, loosen the console retaining strap and remove the G-859 console from the transportation configuration above the battery and swing it out to the side.

Remove the left (facing forward) vertical console retaining strap. Open up both waist belt assemblies. Grasping the G-859 console retaining straps and the right shoulder strap as shown, lift the complete assembly up an onto your right shoulder, making sure the G -859 Console doe not swing into any hard object. See Figures above. Next, work your left arm through the other shoulder harness and seat the pack frame on your shoulders. This may be more easily accomplished with a second person to help make initial adjustments to the fit of the frame.

Figure 18 Wearing the Shoulder Harness

Connect the primary pack frame belt buckle about your hips and tighten the belt. The belt should sit above your hips to support the majority of the pack weight. Identify the secondary Console Waist belt and thread it through the metal tangs on the console attachment bar (see pictures). Attach the console belt buckle and tighten the belt strap as shown in Figure 20. Once the shoulder and waste belts are secure and tightened, attach the second vertical Console support strap and tighten both vertical console straps. This will give vertical support to the console so that it is stable on the front of the body (Figure 21 final assembly)

Finally, connect the front horizontal cross support strap under the clavicles. There are several additional adjustments that can be made to the pack in terms of the waist straps, shoulder straps, console support straps and of course the frame itself. Care must be taken not to use any hardware on the pack other that than which was supplied or that has been screened for magnetic cleanliness.

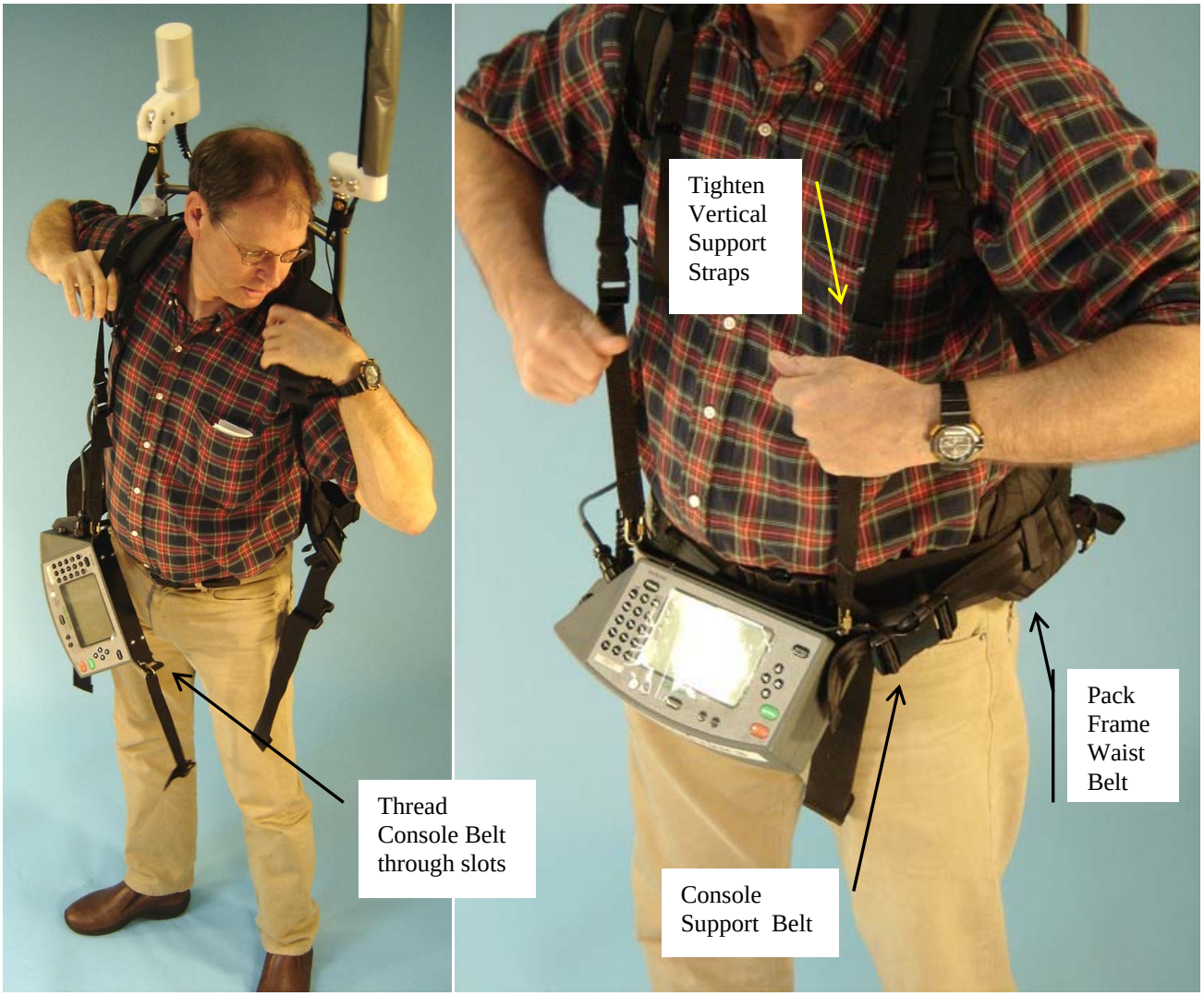


Figure 19 Securing Shoulder straps, console straps and waist belts.

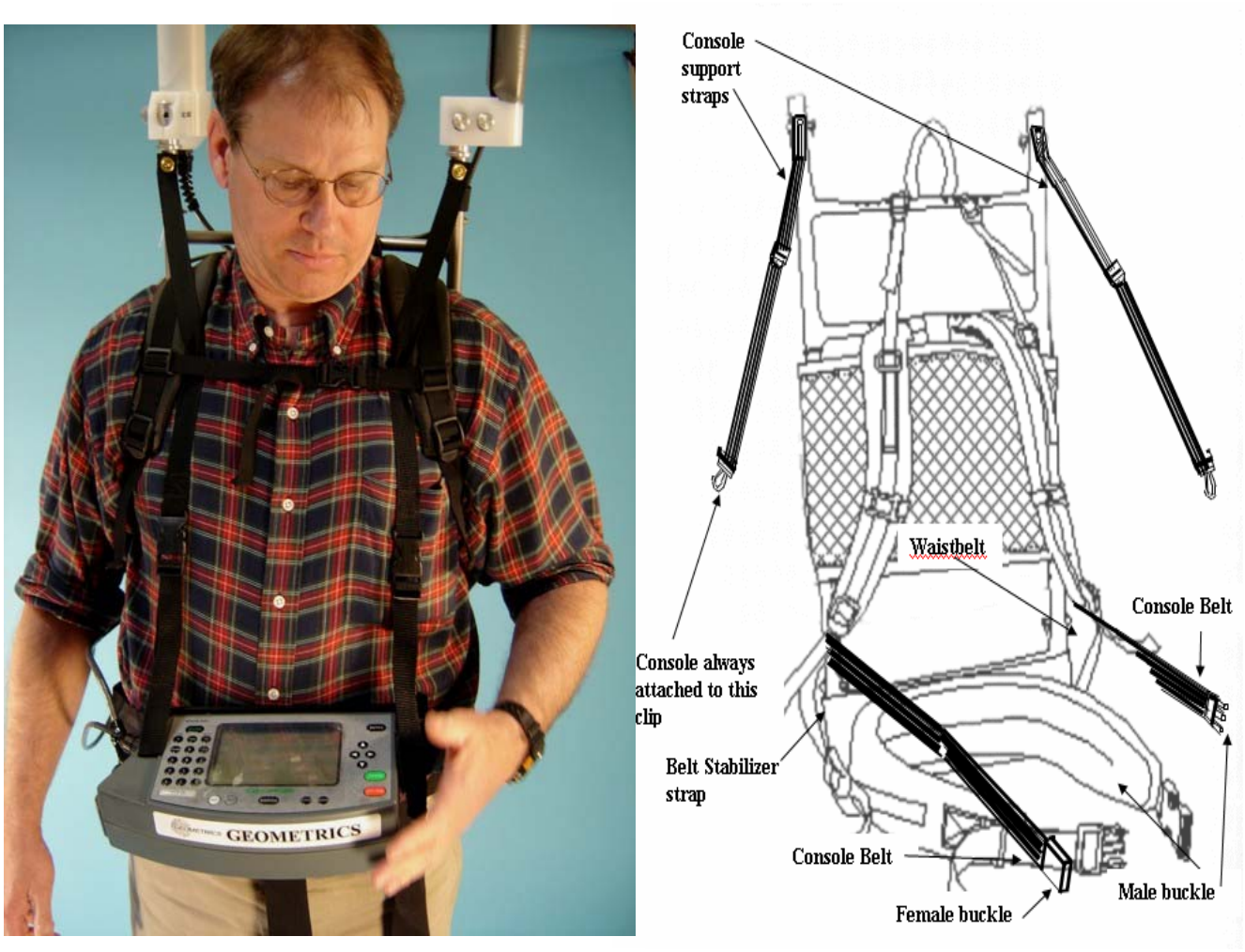


Figure 20 Pack Frame final assembly

Chapter 3: Console and GPS Operation

G-859 Console Operation

The G-859 console is pictured below. The slots in the spreader bar are designed to slip over the console belt. The holes are for attaching the front vertical shoulder straps. The connectors are for the power cable and I/O port (RS-232). The cesium sensor is hard wired into the console.

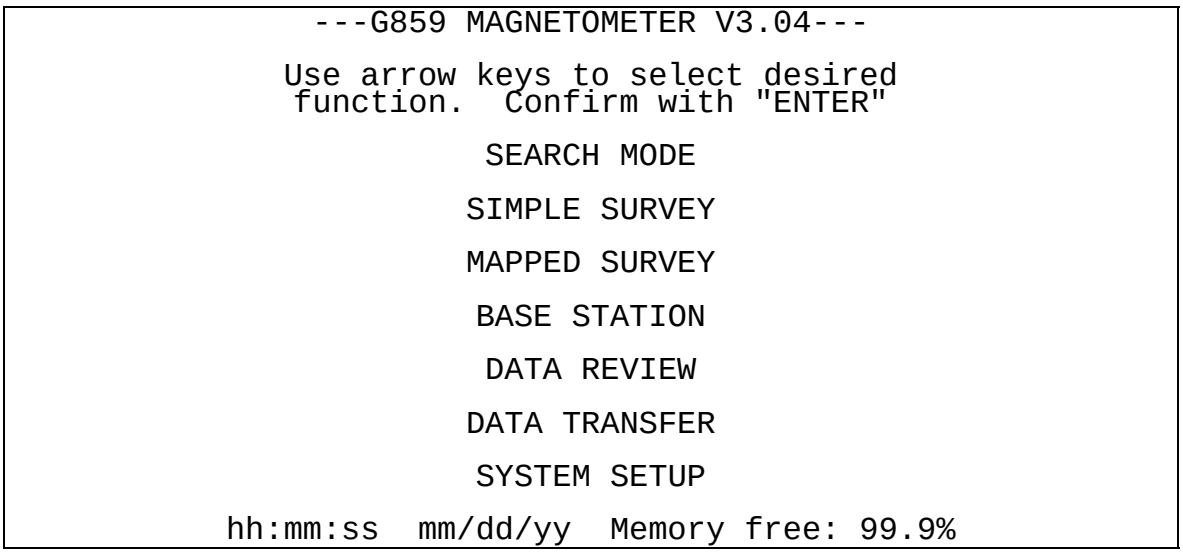
The upper left connector is the battery connector, the upper right is the serial I/O port, and the lower cable is a non-removable connection for the sensor. Note spreader bar attached to the bottom of the console. This bar attaches the console to the Console Belt and the Console Support Straps.

Plug in the Console and Serial I/O cables in to the console if not already connected and turn on the magnetometer by pressing the power button (latest versions of the console have the power button located in the upper center area of the display panel).

Powering on and off

After charging the battery, connect the console to the battery belt cable. This cable may be tucked into the pouch in the battery belt when not in use.

Press the POWER key to power the unit up. You may need to adjust the display contrast (keys marked LIGHT and DARK) in order to see the display. The menu first shown is the Main Menu:



G-859 Magnetometer menu.

Pressing the POWER key when the Main Menu is displayed will shut the unit off. At other times, the POWER key is ignored

Note: To shut the unit off, press ESC until the MAIN MENU, G-859 MAGNETOMETER menu is shown, then press POWER.

Try not to disconnect the battery cable during use. If the battery cable is disconnected, some of the most recent data may be lost. Every effort has been made to protect your data in this event. However, depending upon what the microprocessor was doing at the time power was interrupted, data corruption may occur.

The unit will power itself off when the batteries reach a low voltage condition. Data back to the last position marker will be lost, however.

Note: The gauges on the left of the display show the battery power and memory left in the G-859. You should keep track of these indicators.

High-pitched sounds coming from the G-859 are normal. Capacitors used on the internal circuit boards exhibit a piezo-electric effect, and create the buzzing noises.

Note: You should allow the sensor to warm up for 5 to 10 minutes before starting the survey, depending upon ambient temperature. During the warm up period, the unit may display an "inoperative sensor" message. If this happens, simply unplug the sensor and plug it back in, or cycle the power of the G-859. See the later section "Warming up the G-859" later in this chapter for the proper procedure.

Using the menus

Selecting fields in a menu

Menu fields are highlighted by pressing the up and down arrow keys. There are 3 types of fields which may be highlighted.

Scroll list.

A scroll list is indicated by the angle brackets, < >, on each side (see the "Baud rate" field in the menu example below). Press the left and right arrow keys to scroll through a list of options. You do not need to press the ENTER key. Simply move out of the field with the up or down arrow key, or press ESC to move up an entire menu level.

Numeric entry field.

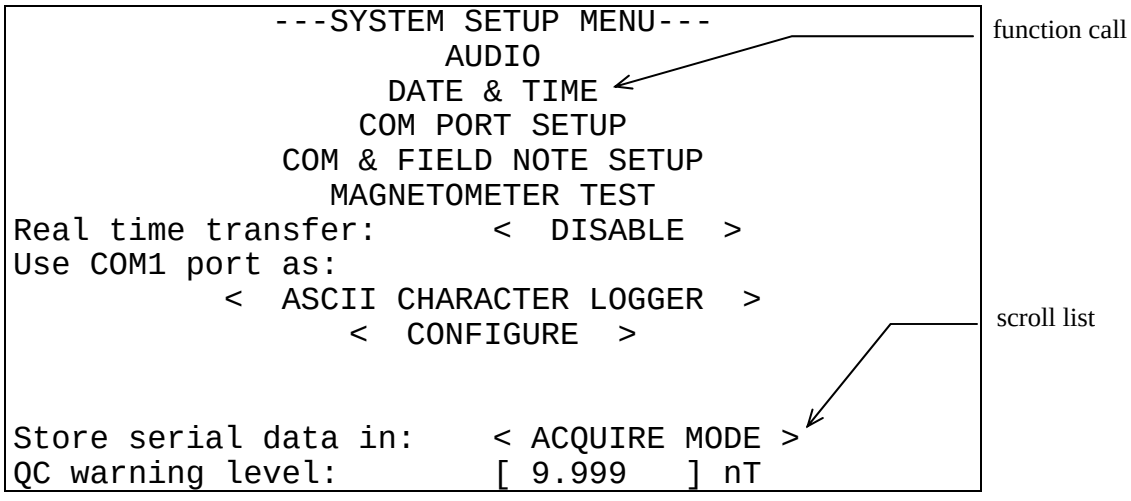
A numberic entry field is indicated by square brackets, [ ], on each side (see the "QC warning level" field in the menu example below). Press the DEL key to delete the number that is there, type a new number, and press ENTER. Using the up and down arrow keys to move out of this field without first pressing ENTER will cause the numeric value to return to the last value.

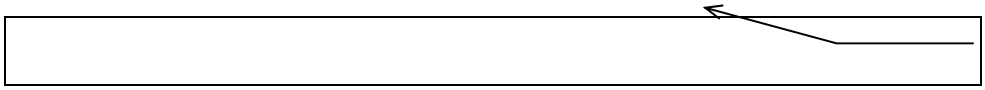
Note: Don't forget to press the ENTER key after entering the desired value. You can also move the cursor within a field by pressing the arrow keys to select and change individual digits.

Function calls.

Function calls are indicated by a text only box, with no angle or square brackets (see the AUDIO, DATE & TIME, and SELF TEST fields in the menu example below). Pressing ENTER in these fields will cause the indicated action to occur.

Menu Example:





Moving through menus

In this document, “selecting” an item means highlighting it with the arrow keys and pressing ENTER. “Scrolling” to a value refers to highlighting the field item and pressing the left or right arrow keys until the desired value is displayed.

Press the ESC key to back up a menu level.

The first menu displayed on power up is the main menu, shown below.

```
          ---G859 MAGNETOMETER V3.04---

        Use arrow keys to select desired
         function.  Confirm with "ENTER"

                   SEARCH MODE

                  SIMPLE SURVEY

                  MAPPED SURVEY

                   BASE STATION

                   DATA REVIEW

                  DATA TRANSFER

                   SYSTEM SETUP

      hh:mm:ss  mm/dd/yy  Memory free: 99.9%
```

G-859 Magnetometer menu.

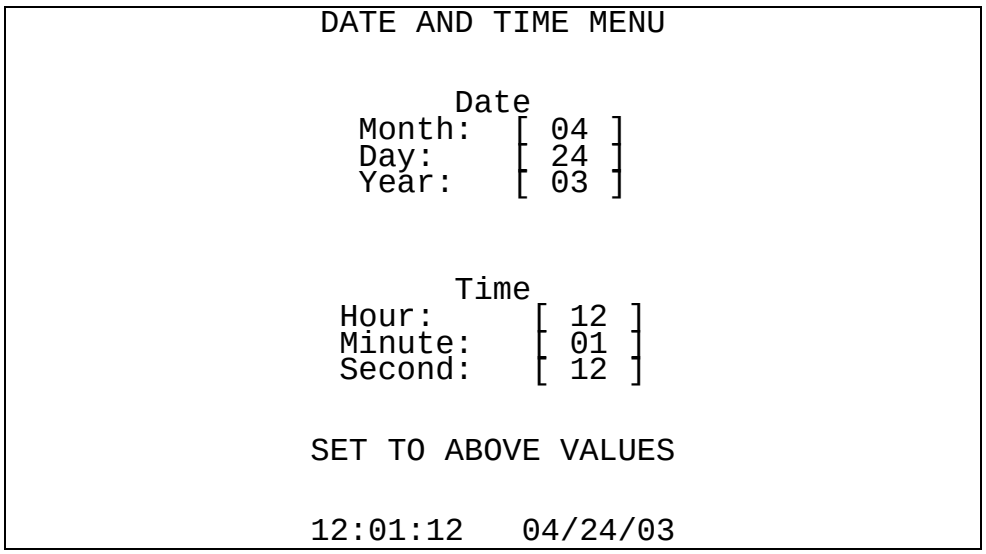
Setting up the G-859

Select the SYSTEM SETUP from the main menu. You will then see the system setup menu.

```
              ---SYSTEM SETUP MENU---
                        AUDIO
                    DATE & TIME
                  COM PORT SETUP
              COM & FIELD NOTE SETUP
                 MAGNETOMETER TEST
Real time transfer:      <  DISABLE  >
Use COM1 port as:
           <  ASCII CHARACTER LOGGER  >
                  <  CONFIGURE  >


Store serial data in:    < ACQUIRE MODE >
QC warning level:        [ 9.999   ] nT
```

Select DATE AND TIME, showing the date and time menu below.



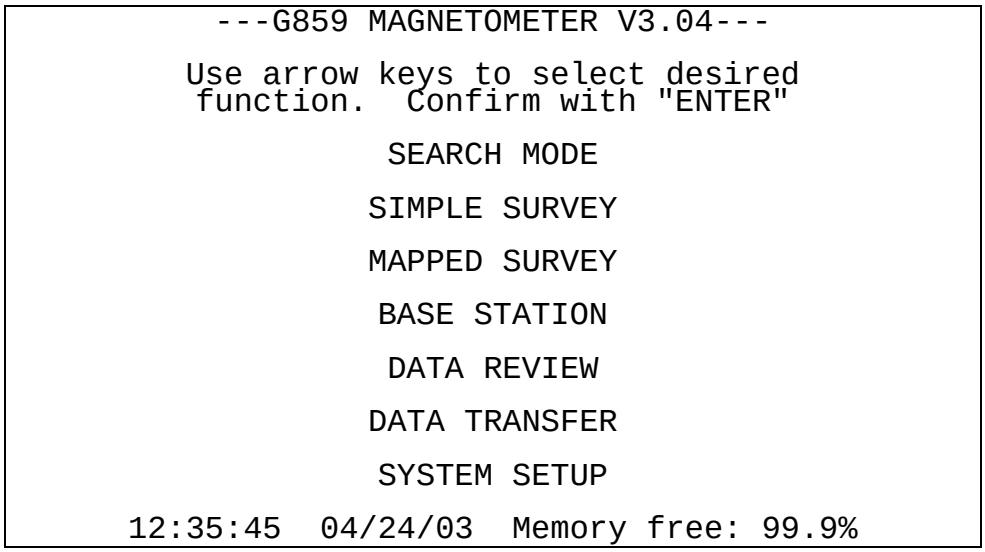
Date and Time Menu.

Enter the correct values in the numeric entry fields, then highlight SET TO THE ABOVE VALUES, and press ENTER. Remember that when you are using a base station for diurnal correction it is critical that you set the base station clock and this clock to the same time. You do this by setting the time slightly in the future and then pressing the ENTER key just at the times synchronize. Hit ESC three times to return to the Main Menu.

Warming up the G-859

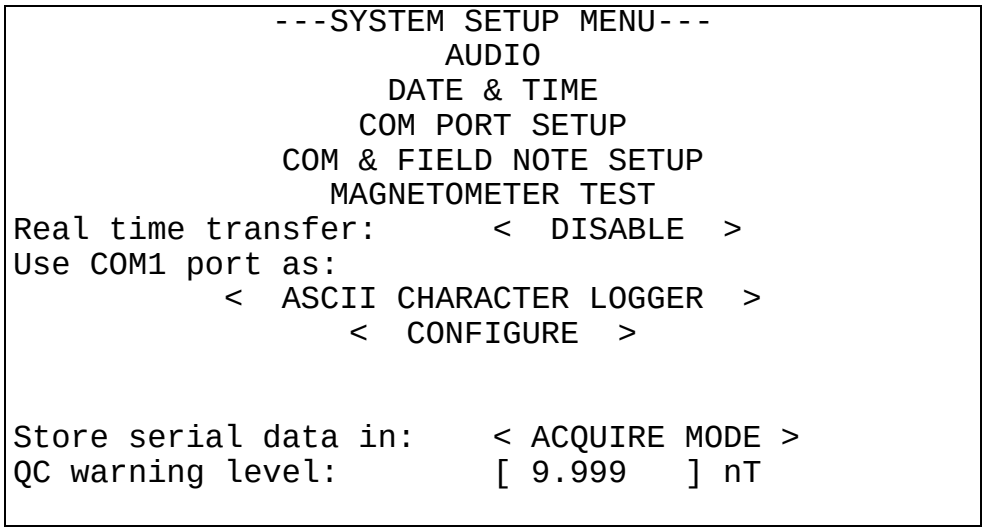
After first powering up the G-859, it may take from 5 to 10 minutes for the unit to warm up and begin operating normally, depending upon the ambient temperature. Here is a recommended procedure for starting and warming up your G-859:

From the G-859 Main Menu:



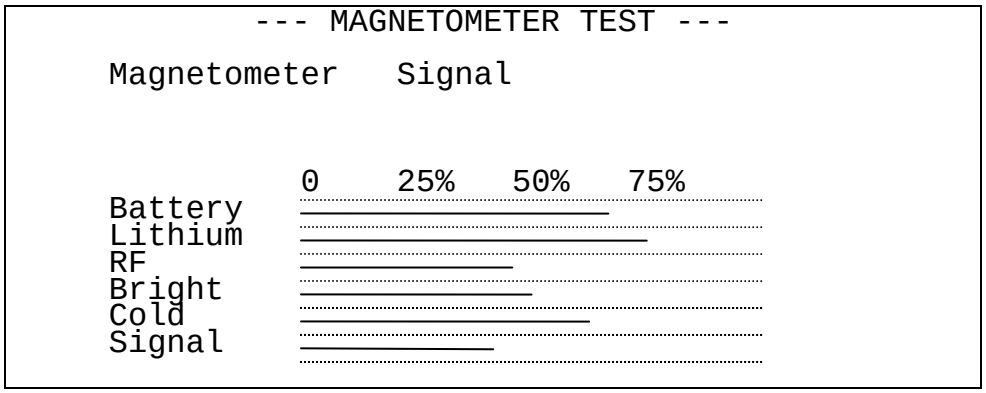
G-859 Magnetometer menu.

Highlight SYSTEM SETUP and press enter. You should see a display similar to that below:



System Setup Menu.

Highlight MAGNETOMETER, and press ENTER. You will now see the following display:



Magnetometer Test Display.

The exact display will differ depending upon how many sensors are installed, and how long the unit has warmed up. The unit is warmed up and operating properly when the Bright1 is maintaining a constant reading of 50%.

If no signal is indicated, it usually means that the sensor is oriented in the dead zone, or the field gradient is too high. Try orienting the sensor differently, and move it away from large ferrous metal objects. Typically, in an office or other indoor environment, gradients are too high, and the sensor signal will often not appear. See the section earlier in this chapter for more information on sensor dead zones.

From this menu, you should also check the level of the Lithium battery. If less than 65% (75% is normal) you should have the battery replaced. This should only be necessary every several years.

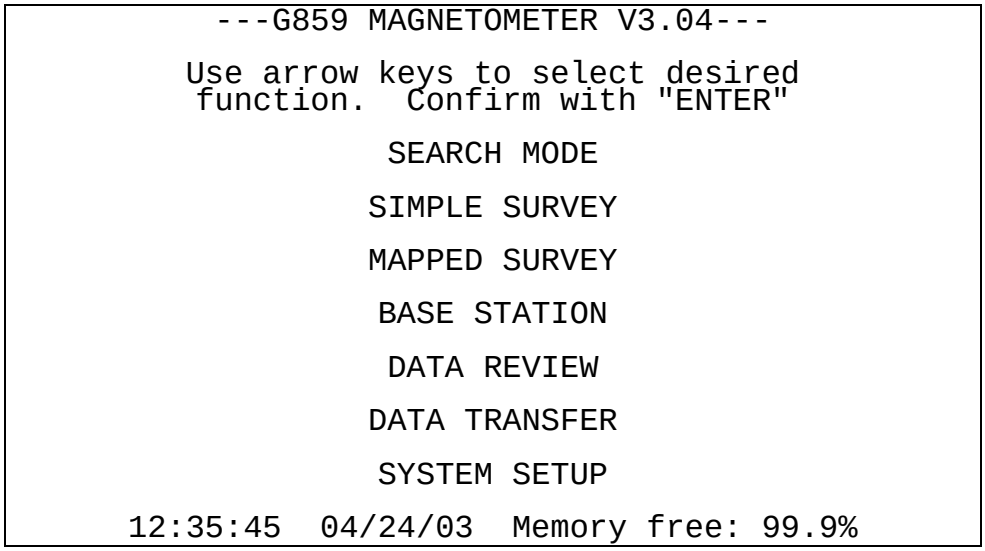
More information about this display is contained in Chapter 10.

Note: Occasionally, the unit may indicate a bad sensor during the warm-up period. If so, press the ESC key to stop the warning sounds, and then simply unplug the sensor and plug it back in. The sensor will then re-initialize, and should come up to the proper operating point.

You should next select SEARCH MODE from the main menu. (Press ESC 3 times to go back to the MAIN MENU). You can then observe the readings as they occur and play with different sensor orientations. The next chapter explains how to use the Search Mode.

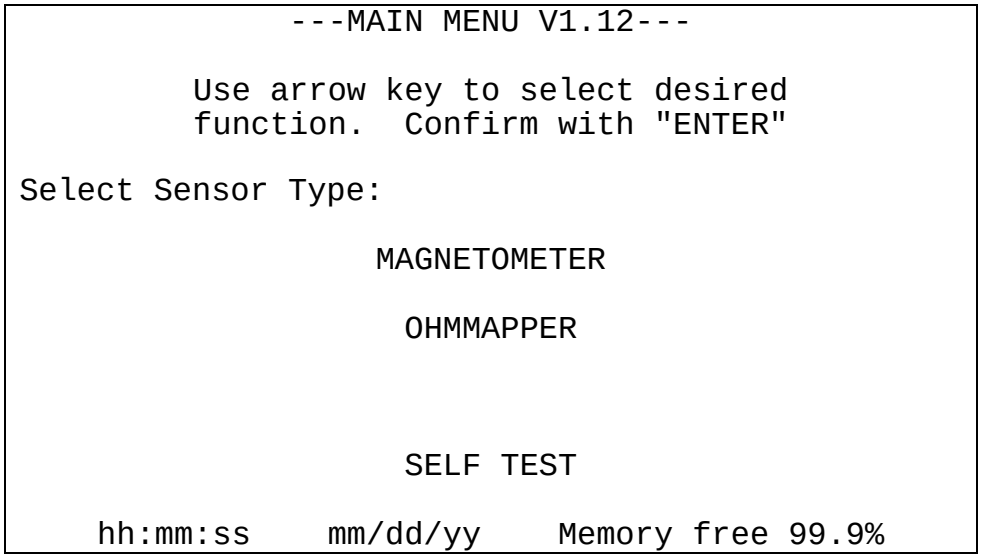
System Setup Menu.

To begin to explore the various modes of operation of the G-859, press the ESC key to return to the G-859 Magnetometer menu and read the chapters that follow.



G-859 Magnetometer menu.

The G-859 also provides other Self Test functions that may be accessed. From the menu shown above select System Setup .



Main Menu

Use the arrow down key to select SELF TEST and press the ENTER key to see the DIAGNOSTIC MENU.

GPS Operation

The G-859 is supplied with an integrated NovAtel Smart Antenna WAAS/EGNOS enabled GPS. This system operates well in most areas of the world although WAAS is not available in all areas (see below). The Smart Antenna and the G-859 logging console are preprogrammed at the factory for proper operation and no further interaction with the interface is required. In the odd event that the Smart Antenna loses its preprogramming, we provide a programming cable and instructions on how to reprogram the GPS in Section 10 of this manual.

The G-859 uses a metronome beat to help the survey operator keep a steady pace. Should the quality of the GPS fix change, the tone of the Metronome will change to indicate poor GPS data. We will be upgrading this manual in the near future with additional information on this feature.

What is WAAS? Basically, it is a system of satellites and ground stations that provide GPS signal corrections, giving better position accuracy than standard GPS. On average the position accuracy is increased up to factor of five times. A WAAS-capable receiver can give a position accuracy of better than three meters 95 percent of the time. There are no service fees to use the WAAS service.

Currently, WAAS satellite coverage is only available in North America. There are no ground reference stations in South America, so even though GPS users there can receive WAAS, the signal has not been corrected and thus would not improve the accuracy of their unit. For some users in the U.S., the position of the satellites over the equator makes it difficult to receive the signals when trees or mountains obstruct the view of the horizon. WAAS signal reception is ideal for open land and marine applications. WAAS provides extended coverage both inland and offshore compared to the land-based DGPS (differential GPS) system. Another benefit of WAAS is that it does not require additional receiving equipment, while DGPS does.

Other governments are developing similar satellite-based differential systems. In Asia, it's the Japanese Multi-Functional Satellite Augmentation System (MSAS), while Europe has the Euro Geostationary Navigation Overlay Service (EGNOS). Eventually, GPS users around the world will have access to precise position data using these and other compatible systems.

Self Test

Selecting SELF TEST from the Main Menu will display the following menu:

```
DIAGNOSTIC MENU

KEYPAD
SOUND
DISPLAY
REAL TIME CLOCK
MEMORY
SERIAL PORT
PICKLE SWITCH
!!! FORMAT MEMORY !!!
```

Keypad
This will bring up a menu for testing the keypad.

Sound
This will emit a continuous sound at maximum volume for you to test your hearing.

Display
Checks to see if the graphics mode of the display is working.

Real Time Clock
Checks the on-board real-time clock.

Memory
Checks the system memory. DO NOT DISCONNECT THE BATTERY DURING THIS TEST. Doing this will result in loss of all data stored in the instrument.

Serial Port
Checks the serial port. You must attach a loop-back cable, available from computer stores, in order to perform this test.

Pickle Switch
Tests the optional external switch.

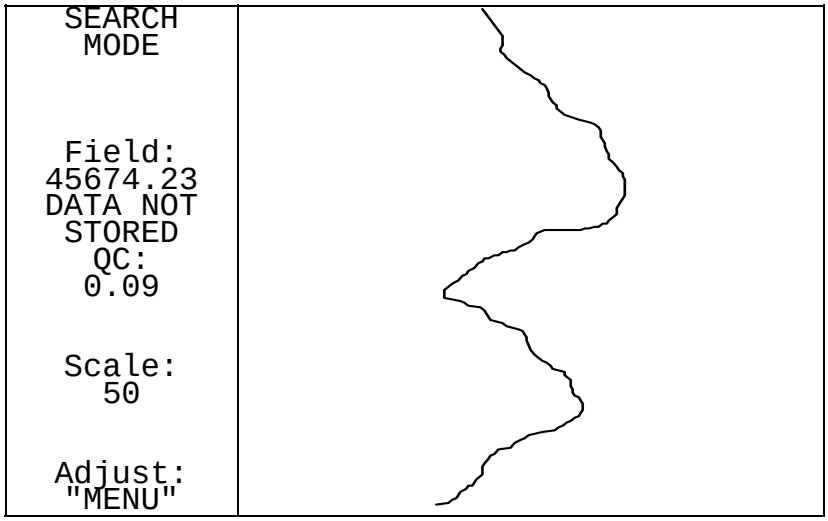
Format Memory
Erases the entire data memory of the G-859. All data in all files will be lost. If the system hangs up at some point, you may need to do this after power up to get the unit to behave properly.

Chapter 4: Search Mode

Search Mode

In search mode, the magnetometer operates normally, displaying data and the woowee audio tones, but data is not stored in memory. This is useful for manually identifying anomaly locations, much as with a metal detector. It is also useful for checking for proper sensor operation and ambient magnetic noise.

Select SEARCH MODE from the main menu. You should see a display similar to that below:

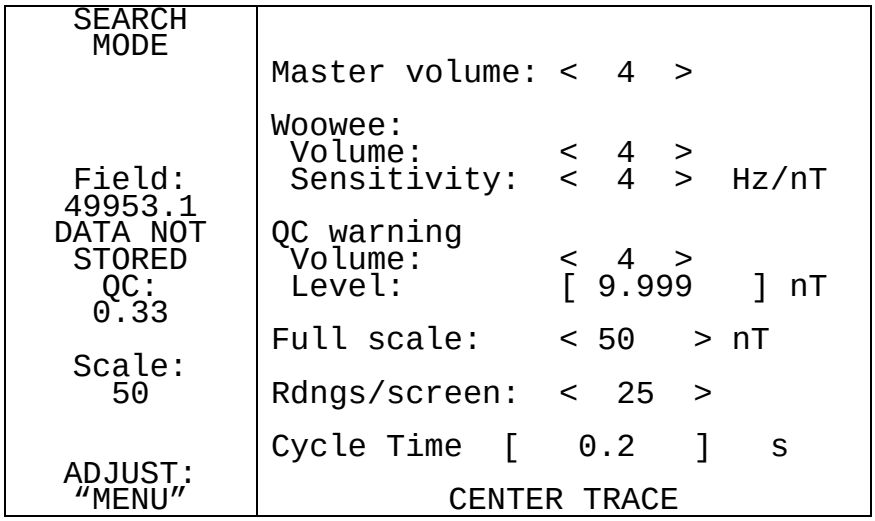


Example of Search Mode Display

Note: Data is not stored in Search Mode. This is indicated on the display, so you do not confuse it with Simple Survey.

Search Mode Adjust Menu

Pressing the MENU key will bring up the Search Mode Adjust Menu. This allows you to adjust the display and audible tones:



Search Mode Adjust Menu.

Master Volume

Adjusts the over-all volume. 1 is softest, 9 loudest.

Woowee Volume

1 is softest, 9 loudest

Woowee Sensitivity

Adjusts the amount the pitch of the woowee changes with varying field readings.

QC warning volume

1 is softest, 9 loudest

QC warning level

Sets the threshold for the QC warning to be emitted. If the QC exceeds this threshold, the warning is sounded.

Full Scale

Sets the trace width full-scale of the display.

Readings per screen

Sets the vertical scale of the trace display. Higher values means the trace moves more slowly down the screen.

CENTER TRACE

Centers the trace in the sweep display.

Pop up Menus

While in Search Mode (and the other modes as well), there are two quick pop up menus that are accessible:

Audio Key

Pressing the AUDIO key will bring up an audio adjust indicator. Then the up- and down-arrow keys will adjust the volume, while the right- and left-arrows will adjust the pitch of the woowee. The audio adjust indicator will disappear after a few seconds.

Scale Key

Pressing the SCALE key will bring up an scale adjust indicator. Then the up- and down-arrow keys will adjust the speed of the sweep (readings shown per page), while the right- and left-arrows will adjust the full scale (in nT). The scale adjust indicator will disappear after a few seconds.

Chapter 5: Simple Survey Mode

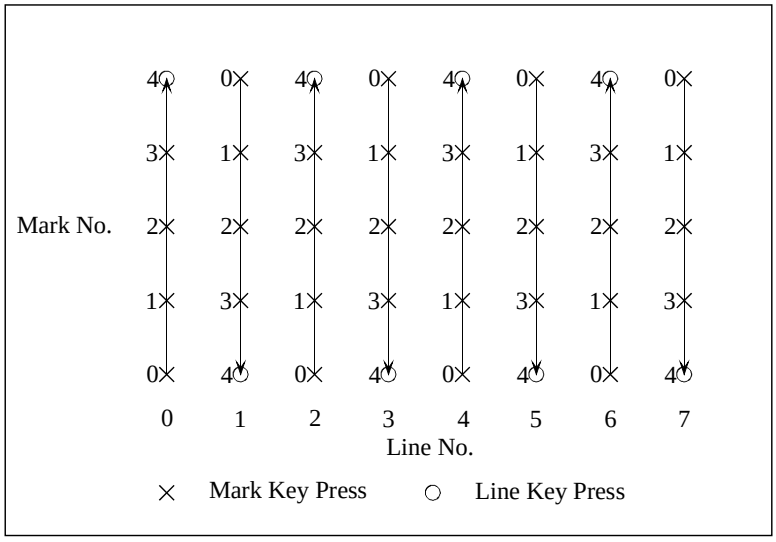
Simple Survey

Once the unit is reading properly in Search Mode, you are ready to begin your survey. If you are unfamiliar with magnetic surveys, please read Appendix 1 and the *Applications Manual for Portable Magnetometers*, shipped with your G-859.

In simple survey mode, the unit keeps track of MARK and END LINE key presses in order to locate the position of the sensor readings. Later, after downloading the data into the PC, you will use the MagMap2000 program to attach an x and y coordinate to each reading.

Survey Overview

Typically, a survey is performed by walking up and down the survey area, surveying a series of lines, as shown below.



Simple Survey Overview

It is most convenient to survey lines walking in both directions, as shown, rather than walking back to the bottom of the map, always surveying up (either method maybe used, however). You will start at the lower left corner of the map, and walk up line 0. pressing the MARK key at each 'X'. At the end of line, press the END LINE key. You will then walk d.own line 1, and so on until the survey is finished.

Note: The line and mark numbers begin at zero. This is the most common convention, and the one adopted in the G-859. It is important to remember this, as it is sometimes easy to get confused. The survey shown above has a total of 8 lines, starting with number 0.

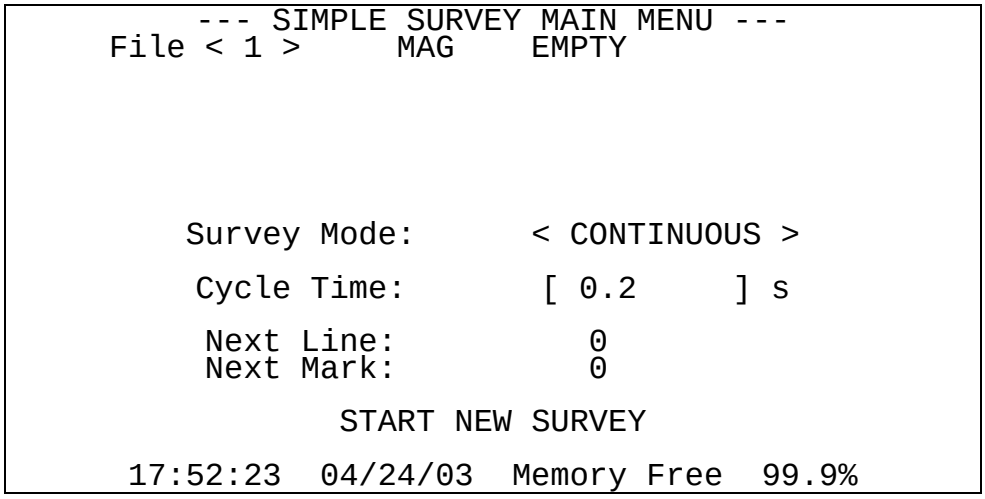
The MARK points are numbered sequentially, even in the case of a bi-directional survey, as shown in the previous figure.

MARK key presses are numbered starting from 0 at the beginning of the line. This is true whether you survey lines walking in both directions or not. The MagMap2000 software will sort out the line direction on the PC.

If a survey is expected to last several hours or more, it is strongly recommended that you set up a second magnetometer as a base station to be used to correct for the diurnal variations in the Earth's magnetic field.

Setting up a Simple Survey

Select simple survey from the main menu, bringing up the simple survey main menu.



Simple Survey Main Menu.

If someone else has already stored some surveys, the menu may not say empty. Highlight the file number, and press the left or right arrow keys until an empty file is displayed. If all 5 files are used, you will need to erase one of them. Please check with whomever has made these surveys to make sure they have downloaded the data. Files may be erased through the DATA TRANSFER section of the Main Menu. See Data Transfer, later in this chapter.

File

File numbers from 1 through 5 may be selected. You may start a new survey from any empty file number, and may continue any Simple Survey file.

Survey Mode:

Set to CONTINUOUS for continuous data acquisition at the rate given by the cycle time, set in the field below. In discrete mode, the unit will take and store a reading at each END LINE or MARK key press.

Cycle Time

This field has two functions. In continuous mode, it sets the rate at which readings are stored. This number also sets the measurement interval. Increasing this interval will increase the resolution, up to the maximum resolution which occurs at 1.5 seconds. Numbers higher than that will increase the spacing between readings, but will not affect the resolution.

In discrete mode, this number sets the measurement interval only. Increasing this number up to 1.5 seconds will increase the resolution. Again, beyond that, the resolution will not increase.

Next Line

Next Mark

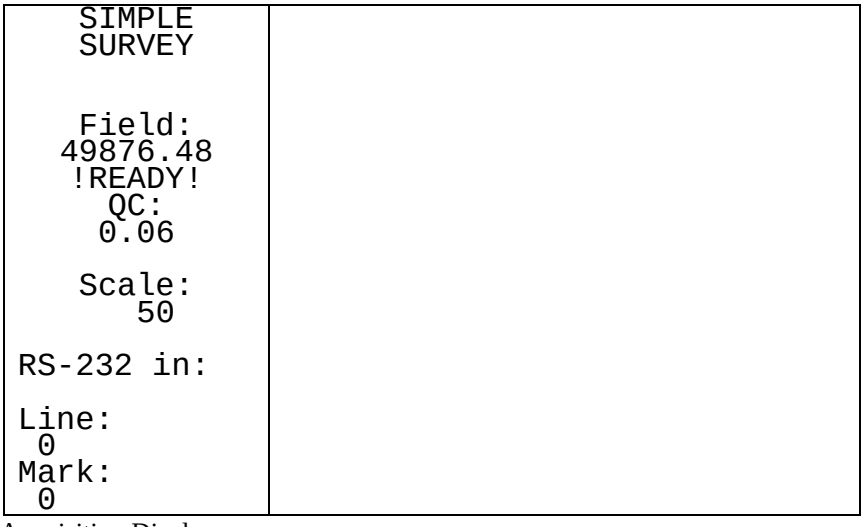
Where the unit expects you to start or continue the survey.

Note: Every new survey will begin at Line=0, Mark=0. After downloading the data into the PC, you will use the MagMap2000 program to specify the actual starting coordinates.

If you wish to continue a previous data set, scroll the data set number to the desired set, then select CONTINUE SURVEY. Data sets for mapped surveys or base station surveys will be shown as the data set number is scrolled. However, from this menu you may not select CONTINUE SURVEY for anything other than simple surveys.

Acquiring Data

Once START NEW SURVEY or CONTINUE SURVEY has been selected, the display will change to the acquisition display.



Acquisition Display.

The items shown on the acquisition display are as follows:

Field:
Displays the magnetic field reading.

READY
Indicates that the instrument is ready to acquire data. Data is not currently being acquired, however.

QC:
Displays a quality check indication. This value grows for rapidly varying fields. If the value exceeds a threshold (set in the system setup menu or the adjust menu) a warning sound will be heard.

Scale
Displays the full-scale width of the sweep trace on the right hand side of the display, in nT.

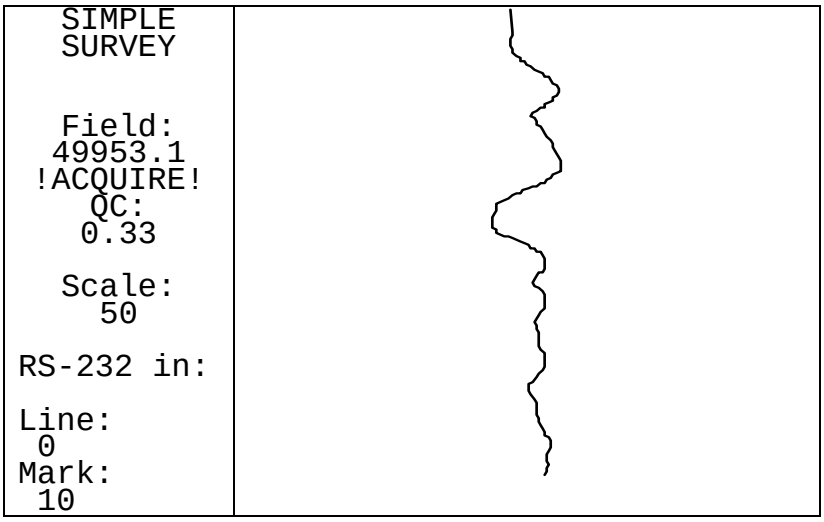
Line
Indicates the line number at which your next END LINE or MARK key press is expected.

Mark
Indicates the mark number at which your next MARK or END LINE key press is expected.

Note: The line and mark number displayed is always the location of the *next* MARK or END LINE key press.

. The unit will not be taking data yet. To start data taking, go to the starting or continuing point (indicated on the display) press the MARK key, and start walking. If you have established way points along the profile, press the MARK key at each way point. Press END LINE when you reach the end of a survey line. Press PAUSE if you want to stop recording, and PAUSE again to resume recording (the PAUSE key is effective only in continuous mode). The data display will indicate the reading with a trace display.

Note: The MARK key performs two operations. It starts the storage of data (at the beginning of a line) and logs positions into memory.



Acquisition Display with Reading Trace.

When you reach the end of each line, press the END LINE key. Upon this action, the unit will stop logging data and display a summary of the previous line:

```
YOU HAVE JUST REACHED THE END OF LINE.
YOU ARE CURRENTLY AT:
```

```
LINE: 0
MARK: 10

PRESS ANY KEY TO CLEAR THIS MESSAGE

THEN PRESS "MARK" TO START NEXT LINE

OR

PRESS "MENU" AND SELECT
"EDIT LINE AND MARK"
FOR EDITING
```

To start the next line, you must first press any key to clear this dialog box, then press MARK as you start walking up the next line. We encourage you to look at this line summary between lines, to make sure you are where the unit thinks you are, and the last line has the right number of mark key presses. If there is a problem at this point, you may edit the most recently taken data. You are not able to edit any except the most recently acquired data.

Note: Don't forget the key press necessary to clear the dialog box. The END LINE key is handy for this since it was the last key pressed. If you forget to clear the dialog box, the next MARK key press will not start data acquisition (it will only clear the dialog box).

Adjust Menu

Pressing the MENU key from the Acquisition Display will bring up the adjust menu. This allows you to adjust the display and audible tones, and to enter the data editing menu.

```
SIMPLE
SURVEY

Field:
49953.1
!ACQUIRE!
QC:
0.33

Scale:
50

RS-232 in:

Line:
0
Mark:
0
```

```
Master volume: <  4  >

Woowee:
 Volume:       <  4  >
 Sensitivity:  <  4  >  Hz/nT

QC warning
 Volume:       <  4  >
 Level:        [ 9.999   ] nT

Full scale:    < 50   > nT

Rdngs/screen:  <  25  >

      EDIT LINE AND MARK

         CENTER TRACE
```

Simple Survey Adjust Menu.

Master Volume

Adjusts the over-all volume. 1 is softest, 9 loudest.

Woowee Volume

1 is softest, 9 loudest

Woowee Sensitivity
Adjusts the amount the pitch of the woowee changes with varying field readings.

QC warning volume
1 is softest, 9 loudest

QC warning level
Sets the threshold for the QC warning to be emitted. If the QC exceeds this threshold, the warning is sounded.

Full Scale
Sets the trace width full-scale of the display.

Readings per screen
Sets the vertical scale of the trace display. Higher values means the trace moves more slowly down the screen.

EDIT LINE AND MARK
Opens the data editing menu. See detail below.

CENTER TRACE
Centers the trace in the sweep display.

Pop up Menus
From the acquisition display, there are two quick pop up menus that are accessible:

Audio Key
Pressing the audio key will bring up an audio adjust indicator. Then the up and down keys will adjust the volume, while the right and left arrows will adjust the pitch of the woowee. The audio adjust indicator will disappear after a few seconds.

Scale Key
Pressing the scale key will bring up an scale adjust indicator. Then the up and down keys will adjust the speed of the sweep (readings shown per page), while the right and left arrows will adjust the full scale (in nT). The scale adjust indicator will disappear after a few seconds.

Pausing
Pressing the PAUSE key while acquiring data will temporarily stop data acquisition. At this point, you may do any of the following:

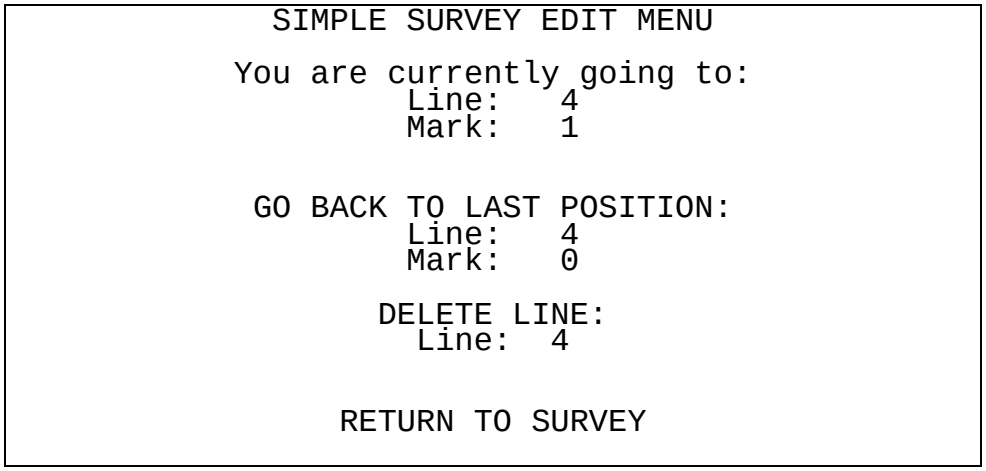
Press PAUSE. This will re-start the acquisition process.

Press MARK. This will enter the current position. Do this only if you are currently at one of your way points. Only one MARK key press is allowed. The instrument will stay in pause mode.

Press END LINE. This will enter the END LINE position. Do this only if you are at the end of the line. The instrument will switch out of pause mode, and into the normal between-line state. Next, press the MARK key to start taking data.

Editing Data

Selecting EDIT LINE AND MARK from the adjust menu (above) will show the edit menu.



Simple Survey Edit Menu.

From this menu, you may delete the most recently acquired data.
The meanings of the menu items are:

GO BACK TO LAST POSITION

Selecting this will delete data to the last MARK or END LINE key press.

DELETE LINE

Selecting this will delete the most recent line. If you are in the middle of a line, the current line will be deleted.

Examples - Recovering From Common Mistakes:

Mistakenly pressing MARK instead of END LINE at the end of a line.

This is a fairly common occurrence, and easily fixed. First, press PAUSE to halt the data acquisition. Then press ESC to close the dialog box. Press MENU, then highlight EDIT LINE AND MARK and press ENTER to bring up the Edit Menu, shown above. Highlight GO BACK TO LAST POSITION and press ENTER. Next, press ESC twice, to show the Acquisition Display. Then press END LINE. You have now corrected your mistake.

Sometimes, after pressing the MARK key at the end of a line, you might press the END LINE key instead of PAUSE, as mentioned above. In this case, from the Edit menu you should highlight GO BACK TO LAST POSITION and press ENTER *twice*. The first press takes you back to the position entered by the END LINE key press (which is one mark spacing past where you want it to be). The second press takes you back to where you actually want the end of line to be. Then, you press ESC twices, and press END LINE.

Mistakenly pressing END LINE instead of MARK in the middle of a line.

After pressing END LINE in the middle of a line, press ESC to clear the dialog box. Then, press MENU, highlight EDIT LINE AND MARK and press ENTER. Next, highlight GO BACK TO LAST POSITION and press ENTER. Press ESC twice to bring up the Acquisition Display.

You are now ready to continue the line where you were when you originally pressed the END LINE key. Position the sensor at the proper location, press MARK, and start walking. You are now taking data.

Realizing the data for your current line is erroneous.

Another common reason for editing data is if you realize a line has incorrect data, often either due to missing a MARK key press at a fiducial point, or walking off course. If this occurs, simply press the END LINE key, enter the edit menu, highlight DELETE LINE and press ENTER. Then select RETURN TO SURVEY (or press ESC), walk back to the beginning of the line, make sure the next line number displayed is correct, press the MARK key and begin the line over again.

Note: From the edit menu, you may delete as many lines or segments as you wish, all the way back to the beginning of the survey.

Summary

Data editing in simple survey is somewhat like pressing backspace on a computer. You can delete data and positions going backward from the most recent key presses. Note that this is the only way to alter the counting of marks and lines.

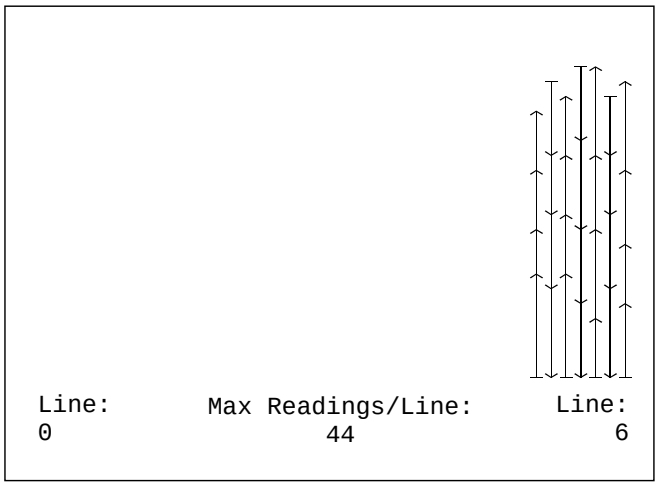
After making data edits, it is very important to make sure the current line and mark number are where you intend to take data. It is strongly recommended that you look at the Map display after editing data. See the next section on viewing data.

Viewing Data

Pressing the MAP or CHART key from the Acquisition Display will bring up a representation of the data acquired. These keys may be pressed at any time. The unit will pause while you look at the display.

Map Display

On the map display, each mark is represented by an arrow in the default direction. The distance between marks is proportional to the number of readings taken. Thus, if you are doing a bi-directional survey, and are walking at a steady pace, this display will correspond to a physical map. Otherwise, it gives an indication of the number of marks in each line and the number of readings taken between marks. The map display, after 7 lines of data have been taken, is shown below:



Map Display in Simple Survey Mode

Data is shifted all the way to the right, with the oldest data shown on the left. The number at the lower left indicates the number of the left-most line, while the right hand number indicates the right-most line on the display. The arrow keys may be used to scroll the display, if necessary.

Pressing ESC will exit the map display.

Chart Display

You may review the data readings as profiles by pressing the CHART key. You may scroll both the map and charts by hitting the left and right arrow keys. If you were logging data when you pressed the MAP or CHART keys, the unit will enter the pause mode while it is displaying the map or profiles. To restart data acquisition, press ESC, then PAUSE. The chart display is shown below:

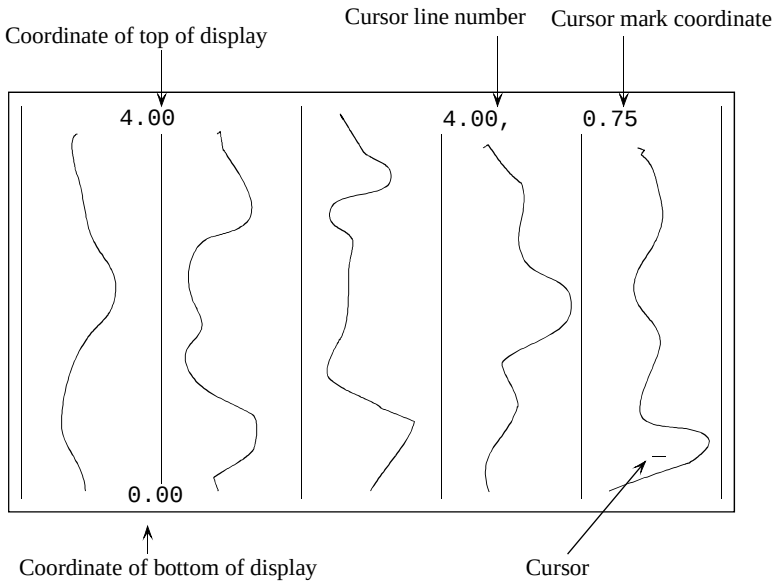


Chart Display in Simple Survey.

On the chart, coordinates are in units of marks. For example, a y-value of 3.5 indicates half way in between mark 3 and mark 4.

Chapter 6: Mapped Survey.

Introduction

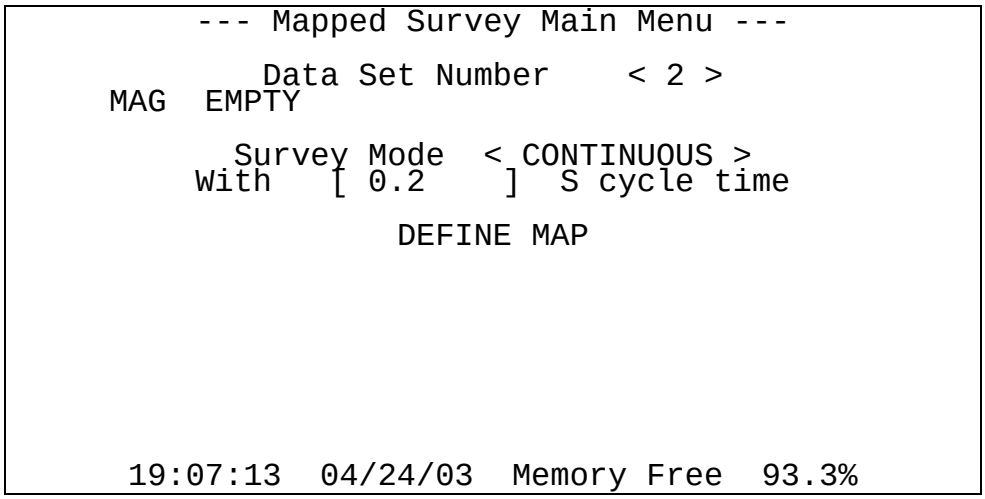
Mapped survey allows you to better specify and visualize the survey area than simple survey, and to move around within the area in a non-continuous fashion. Using the arrow keys, you may position the cursor anywhere within the map, and acquire data. Default cursor movements are programmed into the unit, so if you follow a normal serpentine path across the survey area, you may simply press the MARK and END LINE keys as if you were doing a simple survey.

Mapped mode allows you to

- Define a rectangular survey area with pre-defined fiducial, or mark, points on a regular grid.
- Take data in a uni-directional, or bi-directional default pattern.
- Move to any arbitrary position within the survey area to take data.
- Leave gaps in the survey where positions are inaccessible.
- Observe on-screen where all data points have been logged.

Setting up the survey

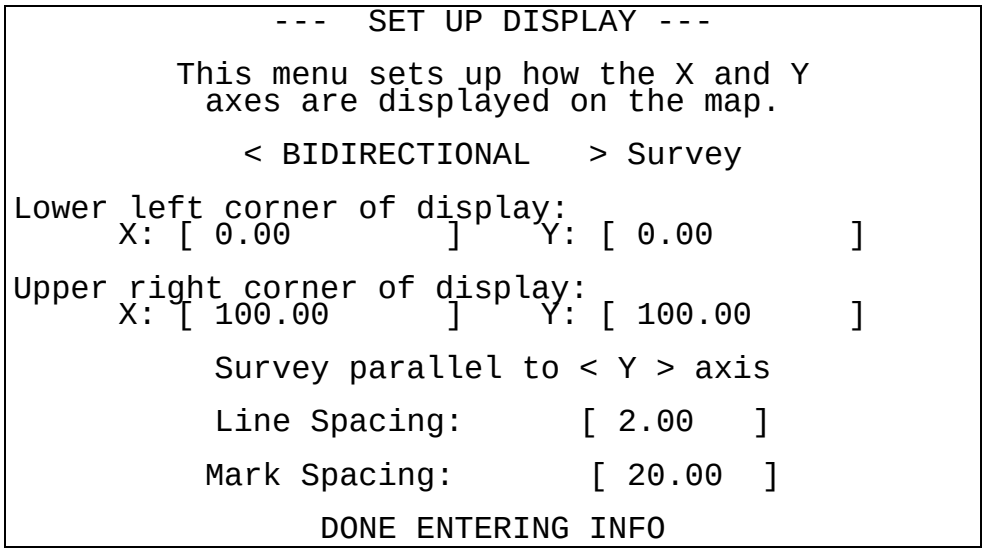
From the main menu, select MAPPED SURVEY.



Mapped Survey Main Menu

To start a new data set, press the right or left arrow keys until an empty data set is indicated. The Survey Mode may be set to continuous or discrete. In discrete mode, a reading will be taken only upon the operator pressing the MARK or END LINE keys. In continuous mode, readings are taken at intervals specified by the cycle time. The cycle time may be set from 0.2 to 6553.4 seconds in 0.1 second increments. Adjust the parameters shown, if necessary, then select DEFINE MAP. This brings up the set up display menu.

Defining the Survey Area


--- SET UP DISPLAY ---
This menu sets up how the X and Y axes are displayed on the map.
< BIDIRECTIONAL > Survey
Lower left corner of display:
X: [0.00] Y: [0.00]
Upper right corner of display:
X: [100.00] Y: [100.00]
Survey parallel to < Y > axis
Line Spacing: [2.00]
Mark Spacing: [20.00]
DONE ENTERING INFO

Set Up Display Menu

The actions of the various fields areas follows:

Bi-directional or uni-directional survey

This field describes whether you will take data walking both up and down lines or walking up the lines only.

Lower left corner

Upper right corner

Here, you must describe the coordinates of the survey area by entering the lower left and upper right extents of the displayed area. If the area is not a rectangular shape, define a bounding rectangle containing the survey site. You may use any units you like.

There are several things you must keep in mind when deciding how to define the survey, and how you will be walking to cover the area. First of all, survey lines are assumed to be shown vertically on the display. This makes it easier to visualize where you are when you are standing at the beginning of a survey line looking towards the end of the line.

Secondly, the unit assumes that you will be surveying lines from left to right across the display. In other words, when the END LINE key is pressed the cursor will move to the next line to the right on the display.

The map height must be an integral number of mark spacings. During the survey, you may manually enter positions at ends of lines which do not reach to the next fiducial mark. See the section "Manually Entering a Position," later in this chapter.

Note: Remember that you are defining the way the coordinates are viewed on the display of the G-859. See the later section "Defining a Physical Area" for more details on how to define your survey.

Survey parallel to X or Y axis

This action defines which axis you want displayed vertically on the screen. This is the axis your lines will be parallel to.

Line spacing

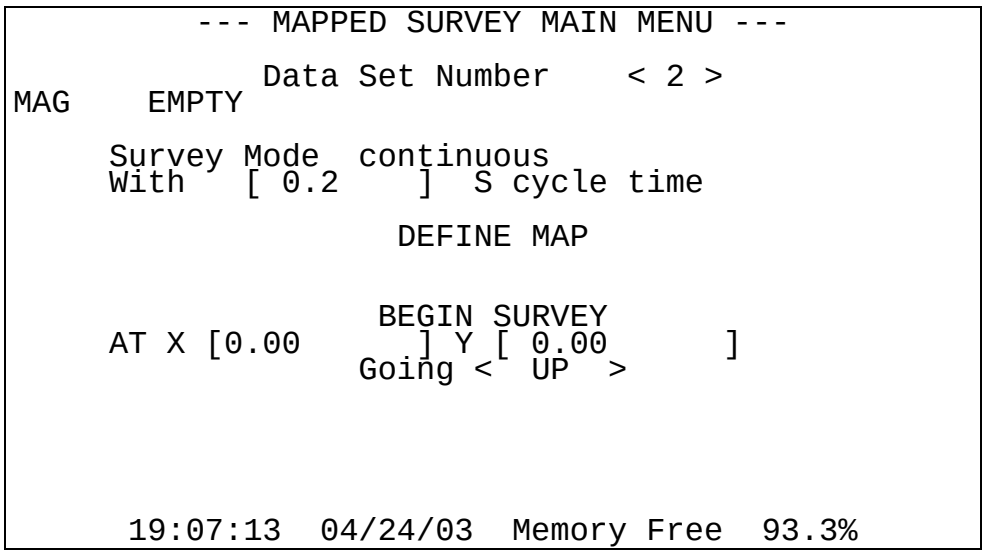
Mark spacing

These items define the distance between lines or marks.

Enter the desired parameters in the set up display menu, then select DONE ENTERING INFO, or press ESC.

Note: If the unit beeps and displays a warning dialog box, you have entered inconsistent information. Usually, this means that the chosen survey direction (x- or y-axis) is not vertical on the display screen. Either change the survey direction or the lower left and/or upper right values for the display. See Defining a Physical Area for more information.

After the G-859 accepts the values you have entered, the mapped survey main menu will reappear, with some new options:



Now you can manually adjust the starting point, if desired. The default starting point will be the lower left corner, and the unit will assume you will be initially walking up the display. You may adjust the starting point and direction, if desired. Then select BEGIN SURVEY.

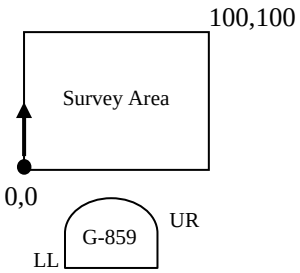
Continuing a previous mapped survey is done in a similar way. Scroll to the desired data set number, then select CONTINUE SURVEY.

Note: You may redefine the map region for a survey that has data in it. This is done simply by selecting DEFINE MAP from the main map menu, and modifying the data. This allows an enormous amount of flexibility in taking a survey. Please see the section “Multiple Grid Surveys” below.

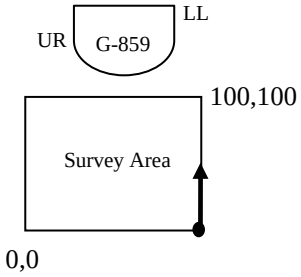
The following provided examples of how to set up the G-859 for varios surveys.

MINING MAG MAPPED SURVEY MODE - PARALLES TO Y AXIS

All coordinates are defined as (x,y)



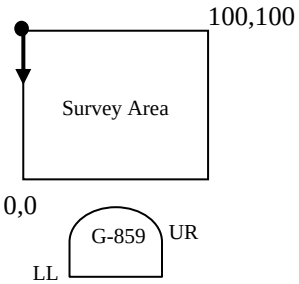
LL(0,0)	Y axis
UR(100,100)	Start UP at (0,0)



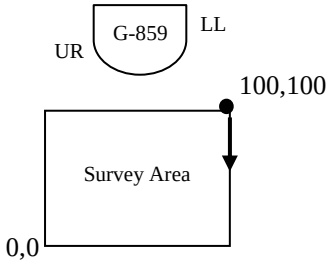
LL(100,100)	Y axis
UR(0,0)	Start DOWN at (100,0)

NOTE: Though you are surveying the area from right to left, the map appears left to right

---



LL(0,0)	Y axis
UR(100,100)	Start DOWN at (0,100)

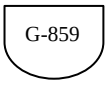


LL(100,100)	Y axis
UR(0,0)	Start UP at (100,100)

NOTES: **UR** is Upper Right, **LL** is Lower Left.

All surveys assume 100 by 100 units. Any rectangular dimension is acceptable.

Represents the start and direction for the first line.

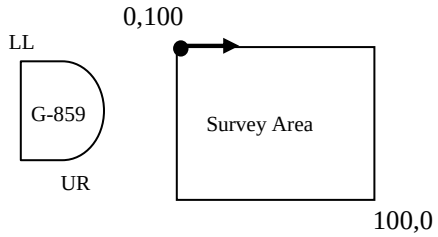


Represents the G-859 Console orientation.

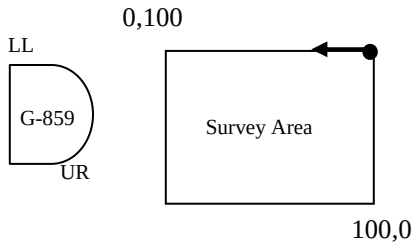
All above Mapped surveys will import into MagMap2000 2000 and result in correctly located data.

MINING MAG MAPPED SURVEY MODE - PARALLEL TO X AXIS

All coordinates are defined as (x,y)

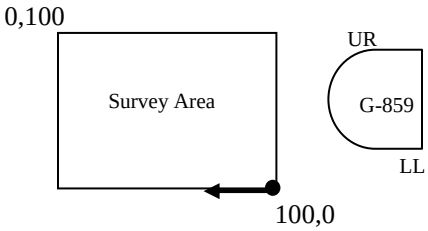


LL(0,100)	X axis
UR(100,0)	Start UP at (0,100)

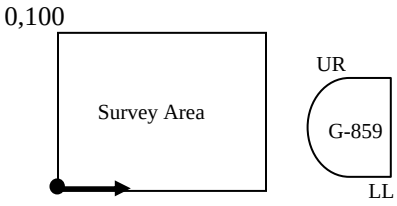


LL(0,100)	X axis
UR(100,0)	Start DOWN at (100,100)
NOT VALID FOR UNIDIRECTIONAL	

NOTE: Though you are surveying the area from right to left, the map appears left to right on the display.



LL(100,0)	X axis
UR(0,100)	Start UP at (100,0)

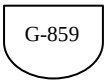


LL(100,0)	X axis
UR(0,100)	Start DOWN at (0,0)
NOT VALID FOR UNIDIRECTIONAL	

NOTES: **UR** is Upper Right, **LL** is Lower Left.

All surveys assume 100 by 100 units. Any rectangular dimension is acceptable.

Represents the start and direction for the first line.

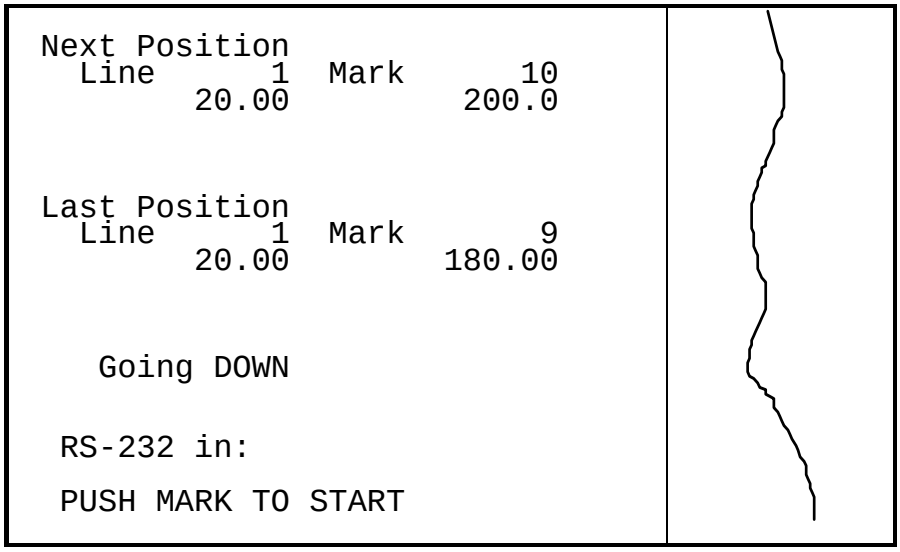


Represents the G-859 Console orientation

All above Mapped surveys will import into MagMap2000 200 and result in correctly located data.

Acquiring Data

Either beginning a new survey or continuing an old one will bring up the map acquisition display.



Data Display Screen

Just as in simple survey, data acquisition is started upon the operator pressing the MARK key. Acquisition will stop when the END LINE key is pressed. Position events will be stored when the MARK key is pressed during data acquisition. The PAUSE key will temporarily halt acquisition; pressing it a second time will re-start acquisition.

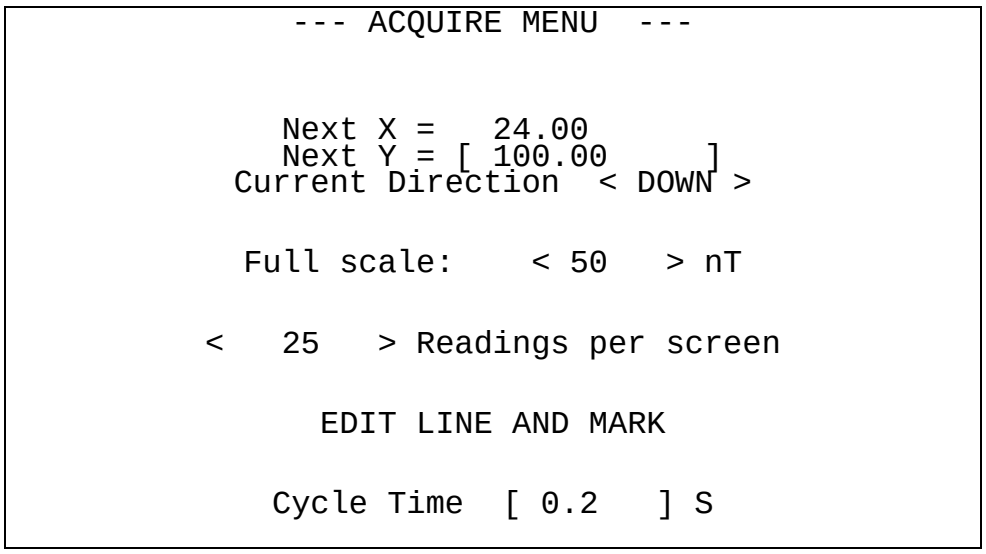
The top line of the display shows the position where you should next press the MARK or END LINE key. This should, of course, be the position you are walking toward. Below this line is shown the position of the last position event stored.

See the Advanced Features section later in this chapter for more information on specifying your position.

Note: From this display, you may press the MENU key to bring up the acquire menu, the MAP key to bring up the map display , or the CHART key to bring up the data review menu. These functions are described next.

Acquire Menu

Pressing the MENU key will bring up the acquire menu.


--- ACQUIRE MENU ---
Next X = 24.00
Next Y = [100.00]
Current Direction < DOWN >
Full scale: < 50 > nT
< 25 > Readings per screen
EDIT LINE AND MARK
Cycle Time [0.2] S

Next X
Next Y

You may change position along the line you are on. Depending on the direction of your survey, you will be allowed to enter a number into one of these two fields. This is very useful when your path is blocked. See the later section "Advanced Features" for more information on using this feature.

If you are between lines, you will be allowed to adjust both of these numbers. You cannot, however, enter a line position which isn't on the regular grid. To do that, you must re-define the grid. See the section on Multi-Grid Surveys.

Note: You may also change the next position by pressing the arrow keys directly from the acquisition display after an END LINE key press.

Current Direction

You may toggle between up and down.

Full scale

The scale width of the sweep display, in nT.

Readings per screen

The vertical scale, or sweep rate on the display.

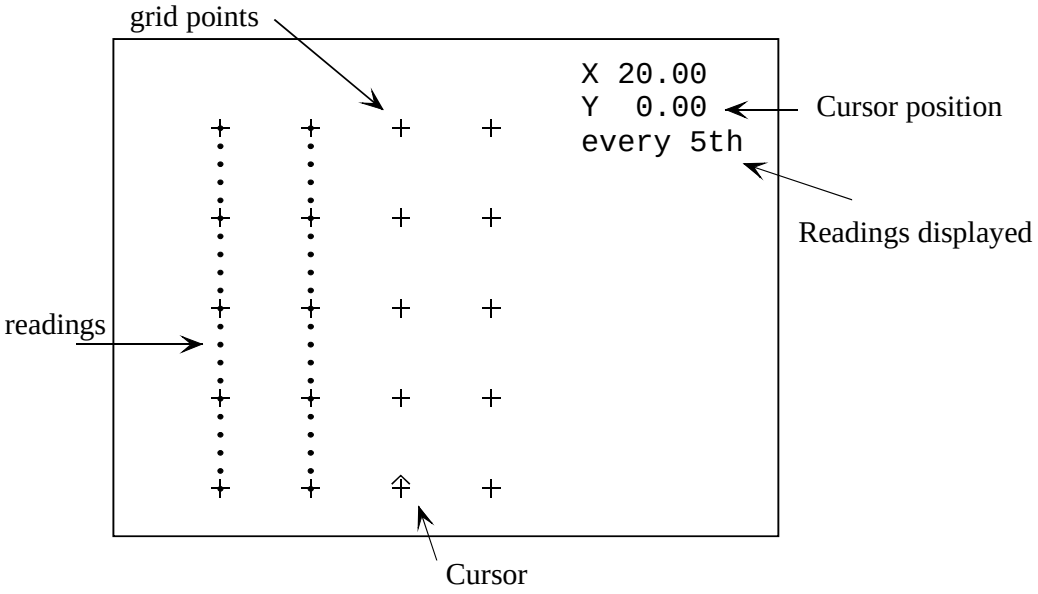
EDIT LINE AND MARK

Brings up the editing menu, see below.

Pressing ESC will return the unit to the acquisition display.

Displaying the Map

The map is displayed by pressing the MAP (.) key from the data display screen:



Map Display. Map is shown after two lines of data have been taken.

Note: To restart data acquisition, first press ESC to clear the map. Then press the MARK key.

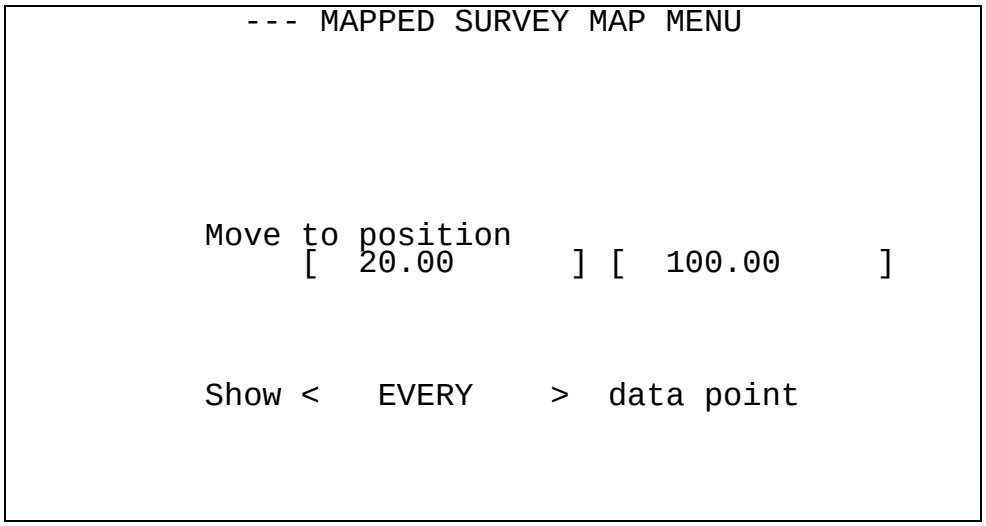
Some care must be taken in orienting the map display with the real world. On the display, the line direction is always up and down. The survey is also assumed to start at the left side of the display. Each time the MARK or END LINE key is pressed, the position is automatically updated on the map, according to whether you have selected a unidirectional or bi-directional survey. The position indicated is where the unit thinks you should be walking toward (where you will next press the END LINE or MARK keys). You may change this to any other fiducial mark by pressing the cursor keys to manually change position.

The baseline of the survey is displayed along the bottom. This is assumed to be a straight line. The edge opposite the baseline may be a more arbitrary shape within the rectangle you specified. This is done by manually entering and changing positions when you are starting or stopping a line at a position other than the back edge of the rectangular map display.

Note: After positioning the cursor, you must make sure it is pointing in the direction you want to go. Pressing "2" will point the cursor upward, and "8" will point the cursor down.

Map Menu

From the map, the MENU key brings up the Mapped Survey Map Menu:



Mapped Survey Map Menu

Move to position

This allows you to position the cursor by entering a position.

Show data point

It also allows you to reduce the number of data points plotted, to speed up the drawing process.

Pressing ESC will return the unit to the map display.

Viewing Data

Data profiles may be reviewed by pressing the CHART (-) key. The arrow keys will scroll through the data. Pressing the SCALE or MENU keys will allow you to adjust the scale.

Each line is plotted in its own lane. Values "wrap around" inside the lane. The scale may be set by pressing the scale key, or by pressing menu and bringing up the Chart adjust menu.

The chart display is shown below.

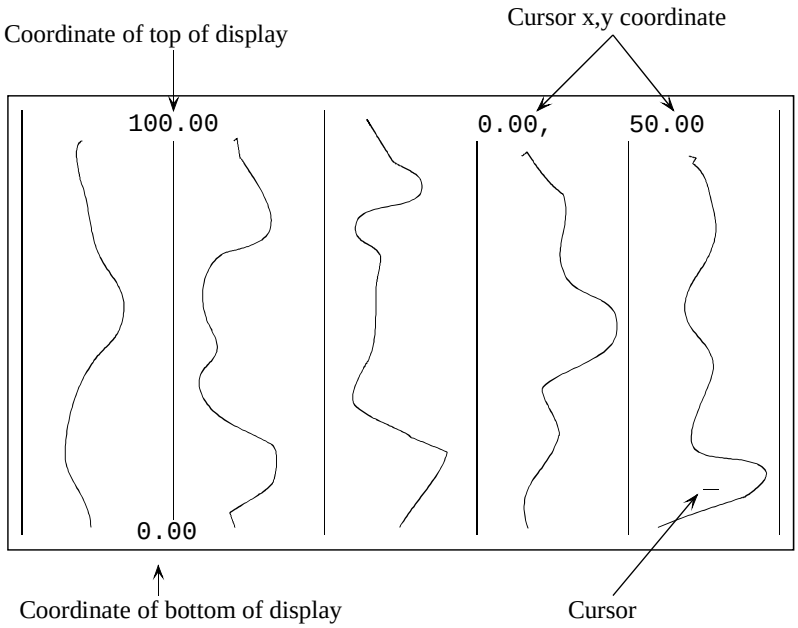


Chart Display for Mapped Survey.

Pressing the MENU key will bring up the data review menu:

```
            --- DATA REVIEW MENU ---


    Move to position:
              X = [  80.00    ]
              Y = [ 100.00    ]


           Full scale:  <  2   >  nT


        Zoom to show  <   ALL  > of line
```

Move to position

This will jump the cursor to a particular position, and scroll the data to that point. This is useful to rapidly page back to a particular point, without having to scroll through the entire file.

Full scale:
Set the full scale of each lane, in nT.

Zoom to show portion of line
Sets the vertical scale of the display.

Editing Data

Introduction

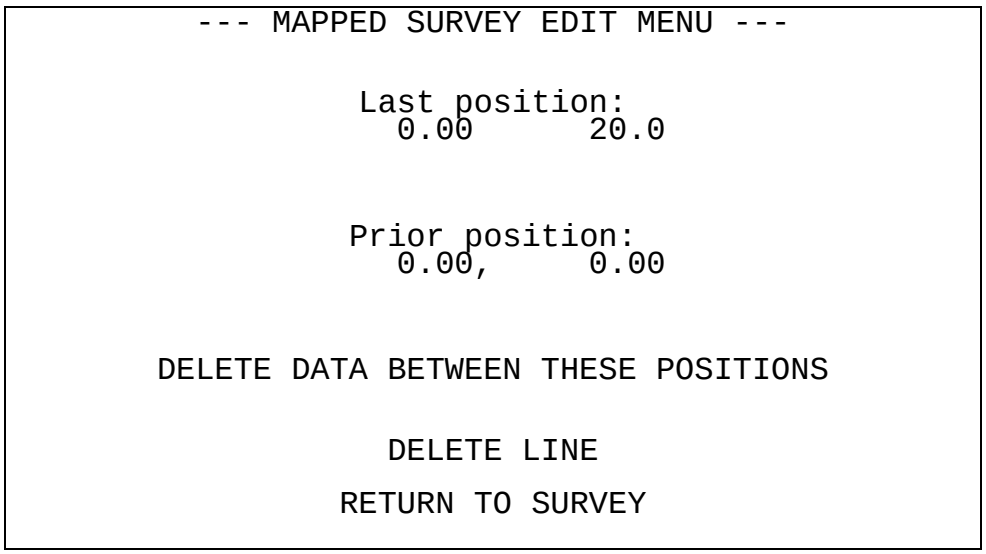
Data editing may be done in two ways. The most-recently taken data may be deleted and retaken, or you may simply retake data from anywhere within the survey. If data has been taken from overlapping locations, the MagMap2000 software will allow you to select which set of data you want. Doing the editing on the PC, however, is an involved process. It is much easier to delete data and retake it on the spot.

Data editing in Mapped Survey is somewhat different from Simple Survey. In Mapped Survey, you have much more flexibility in positioning the cursor where you want when you are finished editing. Thus, if the default position of the cursor is not what you want, you may simply use the map and cursor movement functions to reposition it. You do not need to press the END LINE key, for example, to indicate an end of line. Simply reposition the cursor at the next line.

Also, remember to use the map make sure you deleted the data you intended to. To move from the editing menu to the map, press ESC twice, then MAP. To go back to the editing menu from the map, press ESC, MENU, then highlight EDIT LINE AND MARK (it probably will be highlighted already) and press ENTER.

Procedures

The data editing menu is reached from the acquire adjust menu. From the Acquisition Display, press MENU, then select EDIT LINE AND MARK.



Mapped Survey Edit Menu

DELETE DATA BETWEEN THESE POSITIONS

This function deletes data back to the prior mark. You will then be positioned at that previous mark.

DELETE LINE

This will delete an entire line of data. It will delete the line you are currently on, or, if the current line has no data in it, it will delete the previous line.

Examples - Recovering From Common Mistakes:

Mistakenly pressing MARK instead of END LINE at the end of a line.

First, press END LINE to halt the data acquisition. Press MENU, then highlight EDIT LINE AND MARK and press ENTER to bring up the Edit menu, shown above. Highlight DELETE BETWEEN THESE TWO POSITIONS and press ENTER. Finally, press ESC twice to return to the Acquisition Display. Then press MAP to review where data is still stored on the system, and to make sure the cursor is positioned correctly. You may need to use the arrow keys to place the cursor at the beginning of the desired line.

Mistakenly pressing END LINE instead of MARK in the middle of a line.

This case actually does not require any data or positions to be deleted. In mapped mode, all that is necessary is that you properly re-position the cursor and continue taking data. After accidentally pressing the END LINE key, press MAP to bring up the Map Display. Then, use the arrow keys to position the cursor at the mark position where you pressed the END LINE key. This position will be at the exact end of the last data segment. Next, press ESC twice to move to the Acquisition Display. Now, walk back to where you pressed the END LINE key. Press MARK and start walking. Continue the line normally.

Summary

Data editing in mapped mode is somewhat different than in simple survey mode. In mapped mode, you should visualize the survey area using the map, delete line segments or lines, then reposition the cursor where you want to go next.

To move from the Edit Menu to the Map Display, press ESC twice, then MAP. To go back to the Edit Manu, press ESC, then MENU, make sure EDIT LINE AND MARK is highlighted (it should be) and press ENTER.

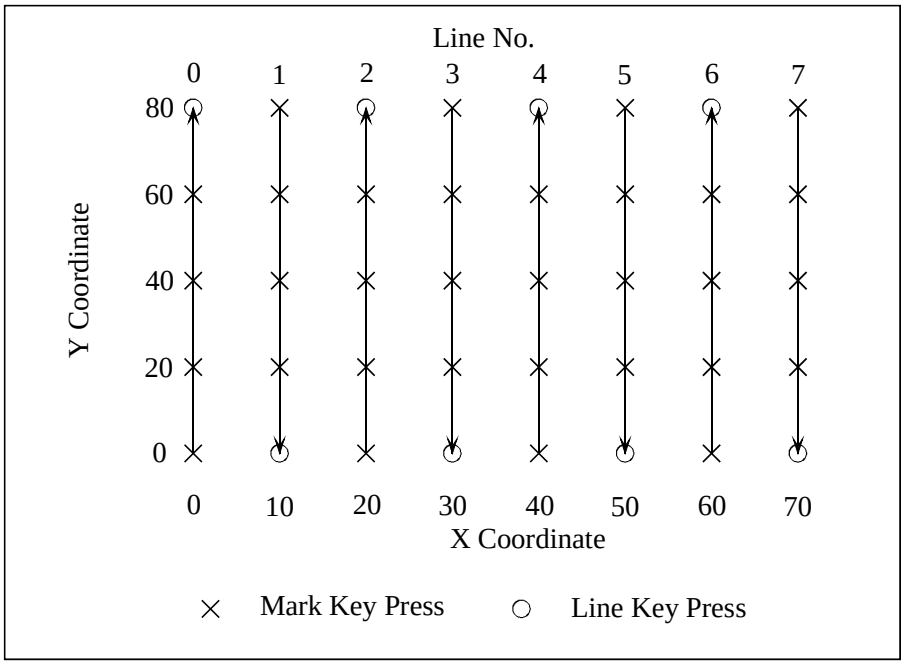
Note: It is strongly suggested that after each segment or line is deleted you bring up the map to see where you now are. Also, don't forget to check to see where the cursor has been positioned, and its direction, after the deletions are finished.

Defining a Physical Area

In the explanation above, we touched only very briefly on defining the map. This section will more clearly explain how to define the map display so that it corresponds to the mental picture you have of the actual survey site.

Normal Orientation

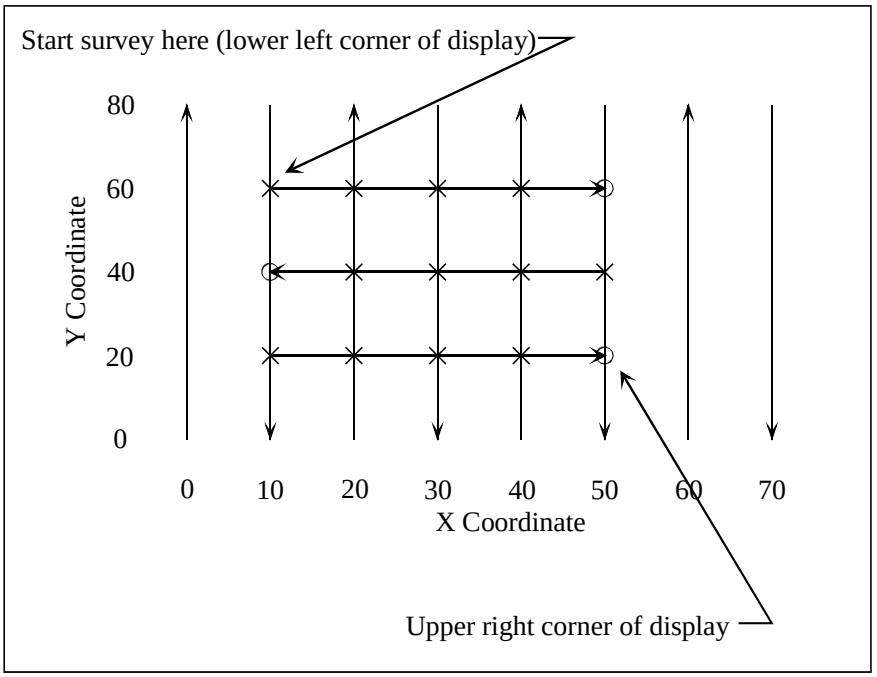
The easiest way to keep the coordinate system clear is to define the Y axis to be the direction along which you are walking, and the X axis perpendicular to that. Then the coordinates will be displayed on the G-859 in the way most people are used to seeing x and y axes, with the y axis being vertical, and the x horizontal. An example of this set up is shown below.

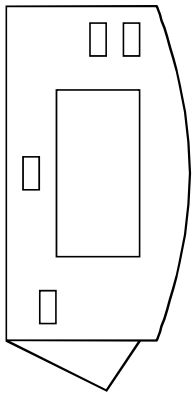


For this case, the lower left coordinate that you should enter in the Define Map Menu would be (0, 0), and the upper right would be (70, 80). The line spacing is equal to 10, and the mark spacing is equal to 20.

90 Degree Orientation

Suppose, however, that you have already defined the x and y coordinates, and do not wish to define the y axis as parallel to the line direction. One good reason to do this is if you are doing a smaller portion of a larger survey, and you wish the coordinates to be consistent. For example, say you want to survey a smaller area within the last survey:





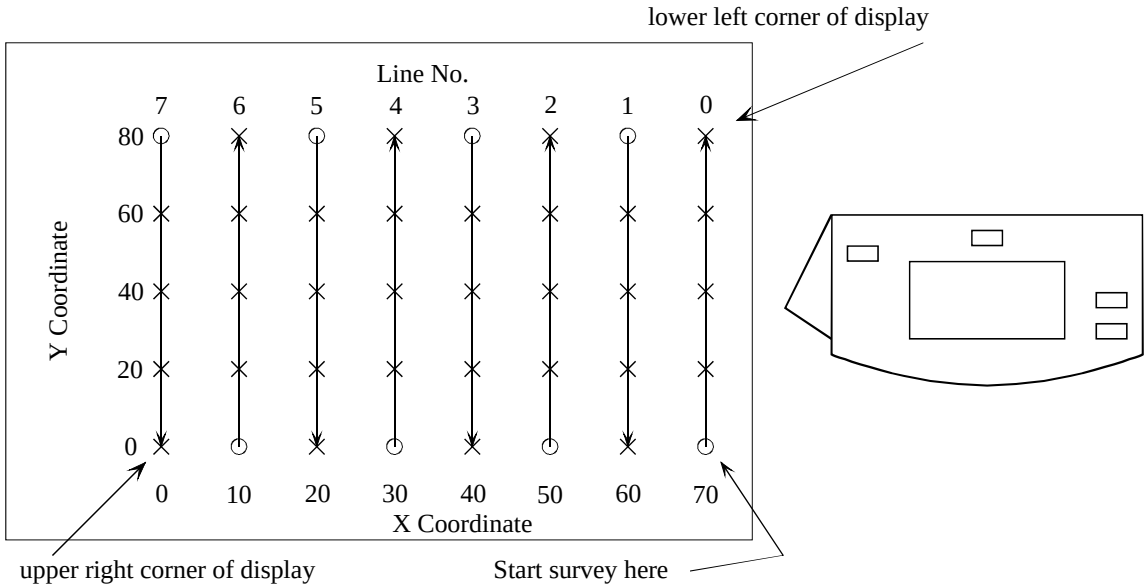
In this case, you would enter the coordinate (10, 60) as the lower left corner of the display, and (50, 20) as the upper right corner of the survey. You would also set the unit to survey parallel to the X axis. You can visualize this by rotating the G-859 clockwise 90 degrees and placing it on the map. For the sub-survey shown, the line spacing is now 20, and the mark spacing 10.

Note: Two things must be remembered in setting up the coordinate systems. First, the line direction is always up and down the G-859 display. Secondly, lines are surveyed starting from the left of the display, and moving toward the right of the display.

180 Degree Orientation

Please note that the G-859 allows you complete freedom in where to start your survey, even though the lines always must move from left to right on the display. You can always rotate the G-859 until the line direction is up and down, and the lines move from left to right. This rotation will determine what coordinate you must enter as the lower left and the upper right of the display. Some orientations will require that you start the survey in the upper left corner of the display. This can be set in the Map Setup Menu before starting the survey.

This can be seen in the following example. Suppose you are back to the original survey, shown in Figure 1, but you wish to start in the lower right corner of the site.



This can be accomplished by rotating the G-859 180 degrees relative to the site map. Then you can see that the correct lower left coordinate is (70, 80), while the upper right coordinate is (0,0). The survey should be begun in the upper left corner of the display.

Advanced Features

The G-859 has many features allowing a great amount of flexibility in defining your position and viewing the survey site. This section describes the ability to define more arbitrary positions, and re-define the survey grid.

Software States

Before discussing the advanced features, it will be helpful to define some states the G-859 can be in, in order to explain when certain operations will work.

There are 3 active states of the G-859 in continuous mode:

Acquire State.

In this state, the system is storing data, generating the woowee tone, and updating the analog sweep trace of the magnetometer output. Pressing the END LINE key sends the system to the Ready State.

Ready State.

This is the state the system is in between lines, for example. Data is not being recorded, the woowee sound is off, and the sweep trace is frozen. Pressing the MARK key sends the system to the acquire state.

Pause State.

The system enters this state from the Acquire State when the pause key is pressed.

Positioning Data

In order to interpolate a position for each individual reading, the system must have a position defined both before and after each segment of readings. Because of this, you cannot press ESC from the acquire state. This would leave a series of readings without an ending position, so the most recent readings could not be properly located.

There are two position recording keys on the G-859: MARK and END LINE. As seen above, these keys, in addition to recording the current position, control the transitions between the Ready and Acquire state. They can therefore be used to start and stop data acquisition.

Press the MARK key at fiducial positions when you want to start or continue data storage. Press the END LINE key at a position when you want to stop data storage. You don't have to be at the actual end of a line to press the END LINE key.

The END LINE and MARK keys also control the automatic tracking of the position. As you have no doubt seen, the positions are automatically updated after each position key press. The MARK key increments (or decrements) the vertical position on the display. The END LINE key advances the horizontal position 1 line spacing.

While using the END LINE and MARK keys to control data acquisition when surveying arbitrarily positioned segments, you must manually update the correct positions.

Manually Entering a Position

You may enter new positions from either the Ready or Pause state. One way to do this is to bring up the map display (press MAP) and move the cursor with the arrow keys. This will allow you to move to any fiducial point. Another way is to bring up the acquire menu (press MENU), and type a new coordinate into the G-859. This allows you to enter positions which are not directly at a fiducial point.

Note: Neither method will allow you to enter points which are not on one of the lines of the survey. To fill in more data between lines, you must redefine the grid. See the section Multi-Grid Surveys in this chapter.

If you are currently in the middle of a series of readings, i.e. you pressed the PAUSE key and haven't yet entered a position, you may only position yourself on the same line you are on.

From the Ready state, you may enter any position along the current line. You can then begin a series of readings from that point.

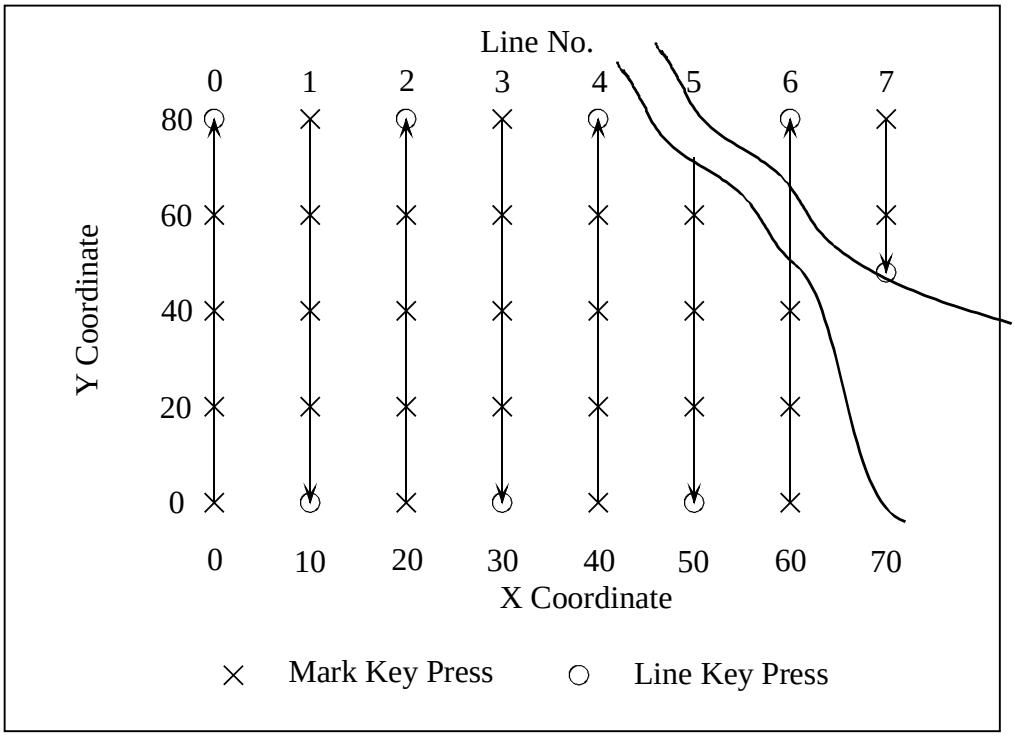
Note: Don't forget to press the ENTER key after entering the value in the numeric entry box.

Example

The principles involved in manually entering positions may best be seen by example. Consider the survey site below, where a stream crosses the survey area. This example shows how to

1. Start a new line at an arbitrary location
2. Leave a gap in the middle of a line.
3. End a line at a specified location

Before going out in the field with your G-859 we strongly suggest that you experiment with this example and observe what happens. This will save much potential confusion out in the field.



Sample Survey Containing an Obstruction.

In the above example, conduct the survey normally until you reach the end of line 4. At that point, press MENU to display the Acqure Menu. Highlight the Next Y field, and enter the value 70. (Press DEL, type 70, then press ENTER). Press ESC to return to the Acquisition Display. Position the sensor at the beginning of line 5 (Y=70), press MARK, and start walking. Proceed normally down line 5, pressing MARK at Y=60, 40, 20, and END LINE at Y=0.

Now begin line 6, by pressing MARK at Y=0, 20, and 40. Upon reaching the stream, press PAUSE. Press MENU, and enter the value 50 into the Next Y field. Press ESC. Press MARK. You have now correctly ended the previous segment of data. After fording the stream, you must enter the starting position of the next segment as described below.

Note: The position entered by an END LINE or MARK key press is the position labeled Next Position on the display. You must update this value *before* pressing the END LINE or MARK keys. If you end a segment by entering an incorrect END LINE or MARK coordinate, the data for that segment will have to be deleted and re-taken, this time with the correct final position.

Press MENU to bring back the Acquire Menu. Enter the position 65 into the Next Y field. Press ESC, then press MARK. You have now entered the starting position.

Note: Entering a value into the Next Y or Next X field in the Acquire Menu will not record the position**.** The MARK key must be pressed to do this, and MARK key presses are only recorded in the Acquisition Display.

To resume collecting data, press PAUSE, and start walking. Press END LINE at the end of line 6.

Note: Notice that data taking was not resumed when the MARK key was pressed. This is because you pressed the PAUSE key when you reached the stream walking up line 6. This puts the G-859 into Pause Mode, and a second PAUSE key press is used to resume data collection. Read the text at the bottom of the Acquisition Display to determine if you are in Pause Mode. If you are, it will say "Press pause to resume." If not, it will say "Press MARK to start" In this latter case, data taking will start when you press MARK. This an important point, so to avoid confusion you should always read the text at the bottom of the display.

Start line 7 normally, by pressing MARK at Y=80 and X=70. When you reach the stream, press PAUSE. Bring up the Acquire Menu (press MENU), and enter 45 into the Next Y field (don't forget to press ENTER). Press ESC,then press END LINE. Notice that you are no longer in the Pause Mode. The END LINE key press moves the system out of that mode.

To observe your handiwork, press the MAP key. You will see that readings are positioned correctly.

Multi-Grid Surveys

As seen above, horizontal locations are limited to grid lines. However, you can change the grid, even in the middle of a survey. This is useful if you want to fill-in parts of a survey with finer spaced lines, or take lines in different directions.

Note: The current grid is used for the automatic tracking of positions, and to define the display extents and fiducial points of the map.

From the Ready state, press ESC to bring up the Mapped Survey Main Menu. Then select DEFINE MAP. Make the changes you desire, then select CONTINUE SURVEY from the Mapped Survey Main Menu. Press the MAP key to bring up the map, and position the cursor where you desire. Then bring back the acquisition display (press ESC from the map). Pressing the MARK key will begin data storage.

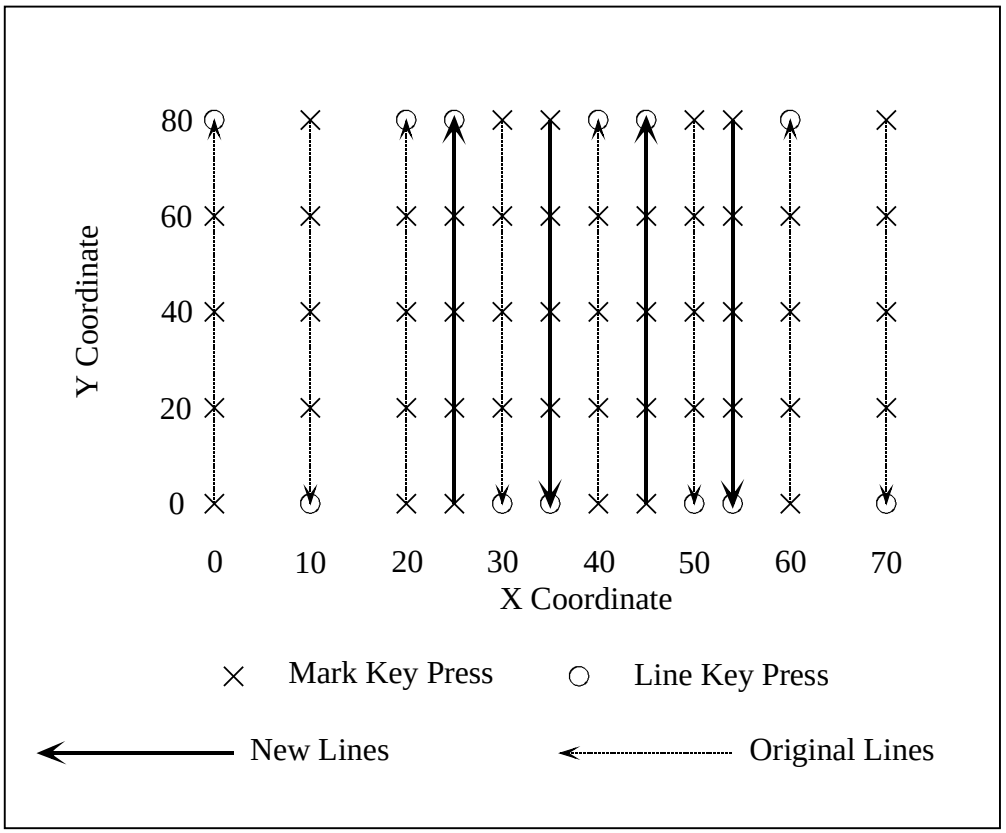
Note: Novices to the G-859 should not attempt this procedure. Another way to do this is to define a new file number, as if this were an unrelated survey. Data can then be located and edited separately, and combined in a program such as Surfer for Windows.

Warning: You may not be able to edit positions in MagMap2000 when using a multi-grid survey. If you use this function, make sure you get the positions correct on the G-859. You must use the NOEDIT method within MagMap2000 in order to locate surveys in which the lines are not parallel.

Note: The map display will only show the current grid. Thus, you may not see data points which were gathered in previous grids. In order to see all of your data points, you could re-define the grid to contain the entire area of interest.

Example 1: Filling in more lines

Suppose you have completed your survey and desire to fill in more lines over a certain portion. Consider the survey shown below.



For the first part of the survey, you would have defined the grid as follows:

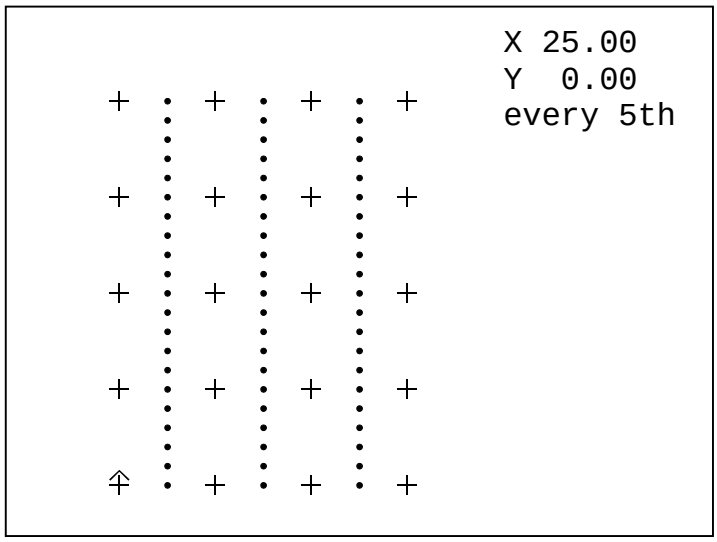
Lower left corner	X= 0.0, Y = 0.0
Upper right corner:	X = 70, Y = 80.0
Survey along	Y axis
Line spacing	10.0
Mark Spacing	20.0

When you have finished the original survey (the light dashed lines), ESC back to the Mapped Survey Main Menu, and select DEFINE MAP. Then enter the following values:

Lower left corner	X= 25.0, Y = 0.0
Upper right corner:	X = 55, Y = 80.0
Survey along	Y axis
Line spacing	10.0
Mark Spacing	20.0

Next, press ESC, then select CONTINUE SURVEY.

Pressing the MAP key will now show what you have done. You should see the following display:



The readings taken for the previous grid are shown. The extent of the map covers only the current grid. However, all data previously taken is still stored in the G-859. You are now ready to survey the new lines in the normal fashion.

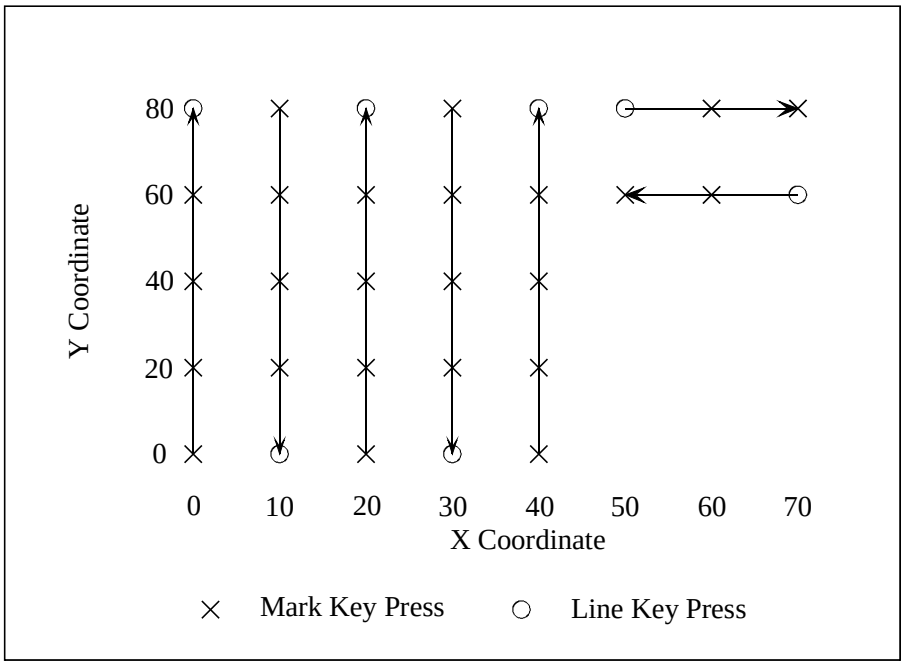
Note: The chart display will not show the old and new lines in the correct order when a multi-grid survey has been performed. The cursor coordinates displayed on the chart display will be correct, however.

Make sure the cursor is positioned where you want it to be. Sometimes, the cursor may not be shown, as it is positioned out of the displayed area. From the map, press MENU, then enter the desired cursor position (X=25, Y=0 in this case). Press ESC to return to the map, and the cursor will be positioned correctly.

After taking all the data of interest, you can confirm that all the data from both grids is still in the G-859. You may do this by re-entering the original grid in the map definition menu, pressing ESC, selecting CONTINUE SURVEY, and pressing MAP.

Example 2

You may also wish to take lines in perpendicular directions. Consider the survey shown below.



For the first part of the survey, define the grid as follows:

Lower left corner	X= 0.0, Y = 0.0
Upper right corner:	X = 40, Y = 80.0
Survey along	Y axis
Line spacing	10.0
Mark Spacing	20.0

When you have finished that, ESC back to the Mapped Survey Main Menu, and select DEFINE MAP. Then enter the following values

Lower left corner	X= 50.0, Y = 80.0
Upper right corner:	X = 70, Y = 0.0
Survey along	X axis
Line spacing	20.0
Mark Spacing	10.0

Then take the next two lines of data. When you download the data, you will be able to locate the points correctly.

Note: MagMap2000 will not be able to edit a survey such as this. You will need to locate the data using the NOEDIT option in MagMap2000. See Chapter 4 for details.

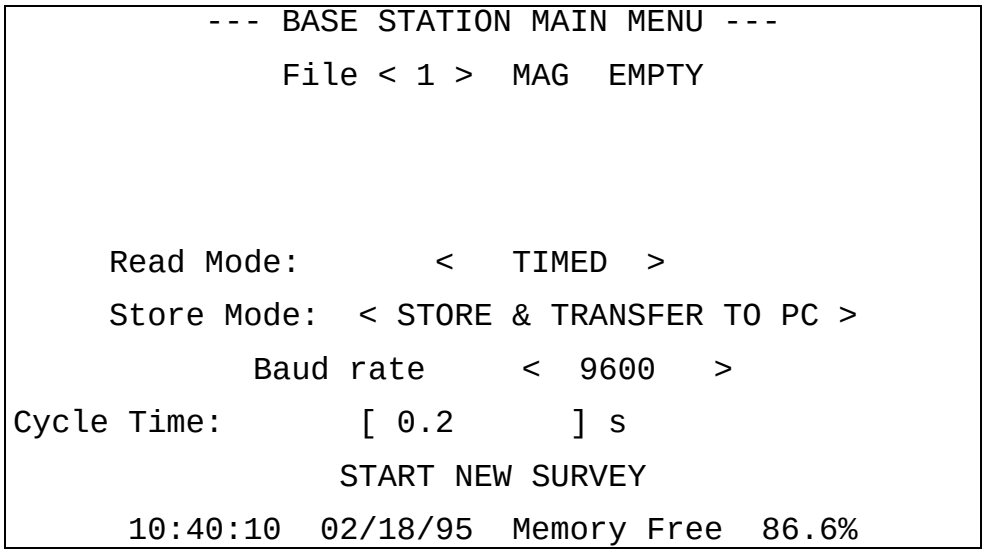
Chapter 7: Base Station

In base station mode, the unit will not keep track of changes in position. This is most useful when the unit is being used to collect data for diurnal correction of another, roving, unit's data. This procedure is accomplished in the post-processing of your data, using the MagMap2000 program. See Chapter 4 for more details.

In addition, this mode supports a real-time transfer of data out of the RS-232. This is useful if you are using another PC to collect and process the data. Of course, you may also store the data inside the G-859, with or without real-time transfer.

Setting up a Base Station Survey

From the main menu, select BASE STATION. The base station main menu will appear:



Base Station Main Menu

Scroll to an empty file, or select the base station file you wish to append data to. The fields are as follows:

Read Mode.

May be set to TIMED or TRIGGERED. In TIMED mode, data will be read at timed intervals, set by the cycle time field in this menu. In trigger mode, data will be read and stored by pressing the MARK key.

Store Mode

May be set to STORE IN MEMORY ONLY, STORE AND TRANSFER TO PC, or TRANSFER ONLY. Transferring data means sending it out the serial port as it is being collected. Storing means storing the data in the on-board memory.

**NOTE: If the STORE IN MEMORY AND TRANSFER option is selected, then when the memory if full, after 5 or 6 hours the magnetometer WILL STOP TRANSFERING DATA. For this reason, if long term unattended base station use is considered, w*e strongly suggest you use the TRANSFER ONLY* setting. Then the magnetometer will continue to take readings and transmit them as long as there is battery power.

Baud rate

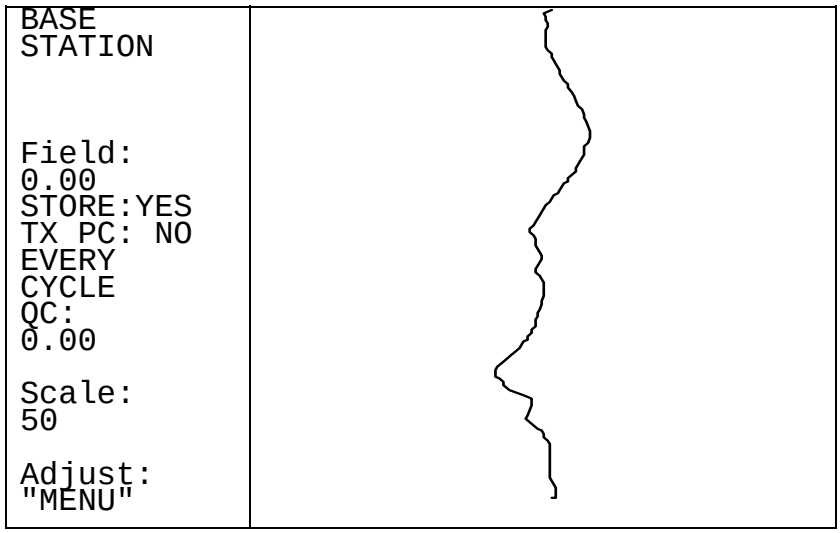
This field is shown only if transferring to PC was selected in the above field.

Cycle Time

Sets the time interval between readings. Also sets the measuring interval. Increasing the measuring interval will increase the sensitivity of the magnetic reading. Setting the cycle time to greater than 1.5 seconds will change the time between readings, but will not affect the sensitivity.

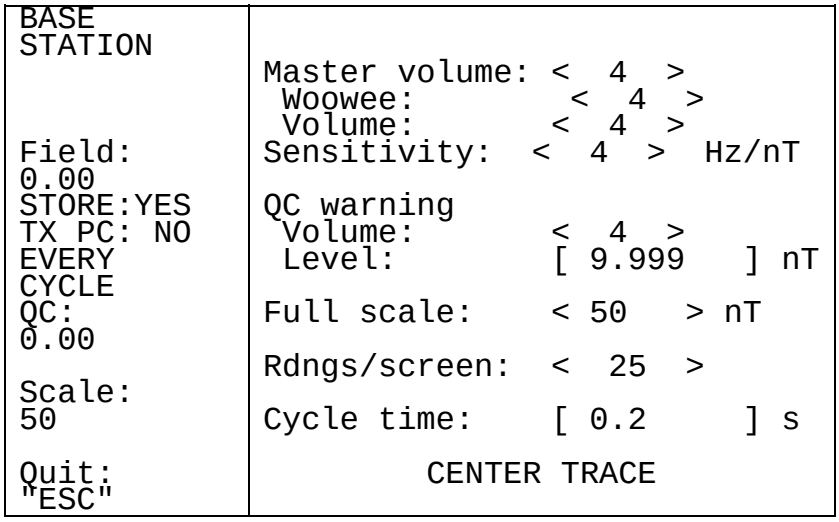
Acquiring Data

Once the parameters have been set to your satisfaction, highlight START NEW SURVEY and press Enter to begin data collection. The base station acquisition menu will be displayed, as shown below.



Base Station Acquisition Display

To adjust certain parameters, press the MENU key to bring up the adjust menu: This will allow you to set the volume, the scale, the woowee pitch and sound level, and center the trace.



Base Station Adjust Menu

The audio and scale may also be adjusted directly from the acquisition menu.

Audio Key

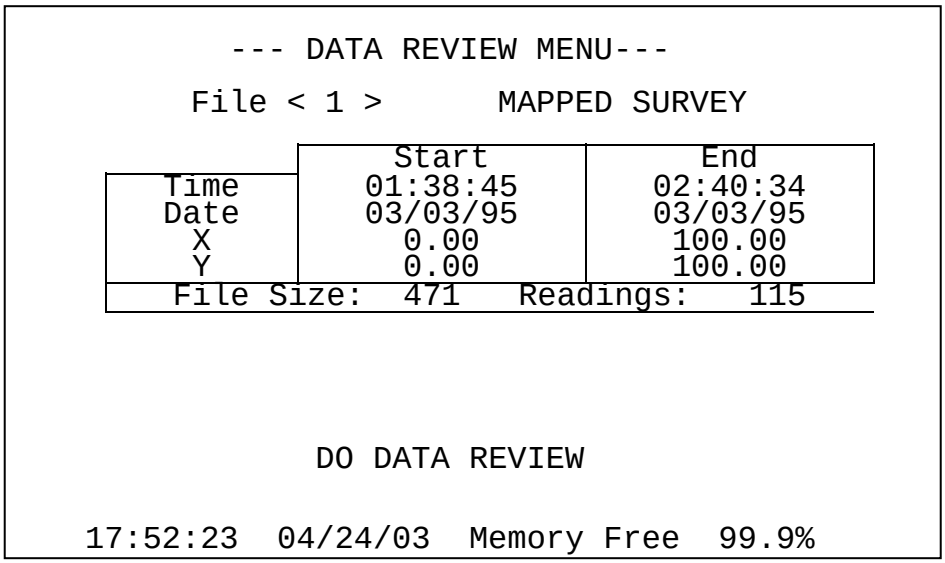
Pressing the audio key will bring up an audio adjust indicator. Then the up and down keys will adjust the volume, while the right and left arrows will adjust the pitch of the woowee. The audio adjust indicator will disappear after a few seconds.

Scale Key

Pressing the scale key will bring up an scale adjust indicator. Then the up and down keys will adjust the speed of the sweep (readings shown per page), while the right and left arrows will adjust the full scale (in nT). The scale adjust indicator will disappear after a few seconds.

Chapter 8: Data Review

Enter the Data Review mode by selecting DATA REVIEW from the main menu. An example display is shown below. Your display will differ, depending upon the type of survey used for a particular file number.



This menu shows the directory of each survey stored in the G-859. Scrolling the file number will scroll through the files.

Selecting DO DATA REVIEW brings up the chart display for the selected file number.

Chart Display

The chart display varies slightly depending upon whether the survey is a simple survey, mapped survey, or base station.

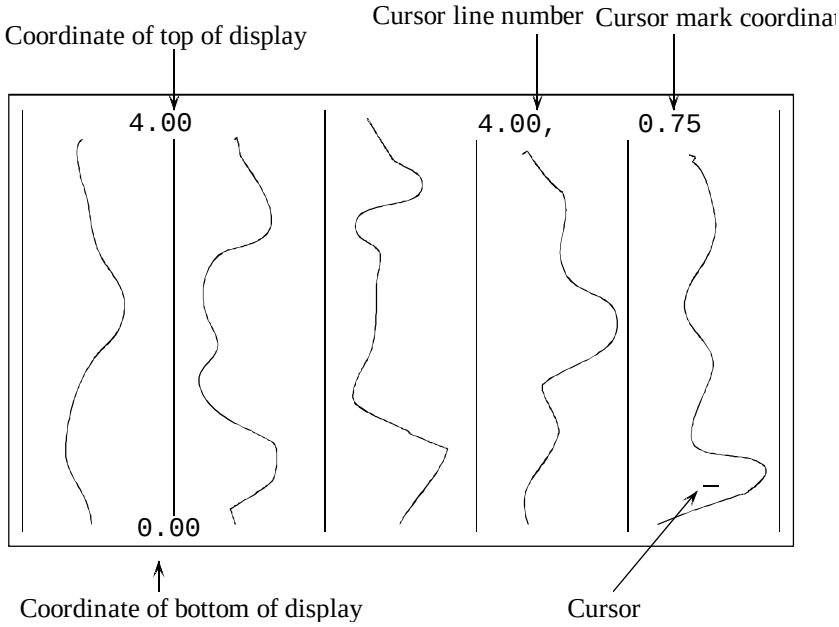


Chart Display for Simple Survey

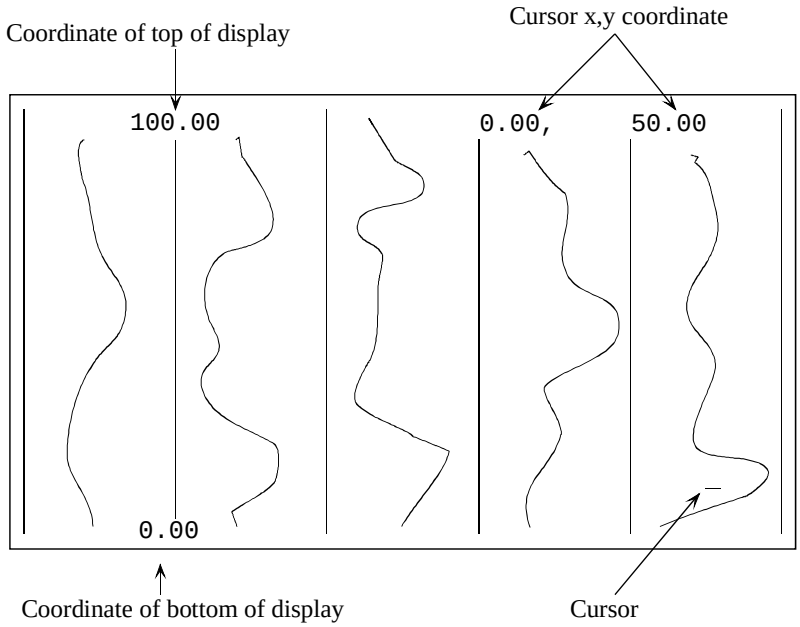


Chart Display for Mapped Survey

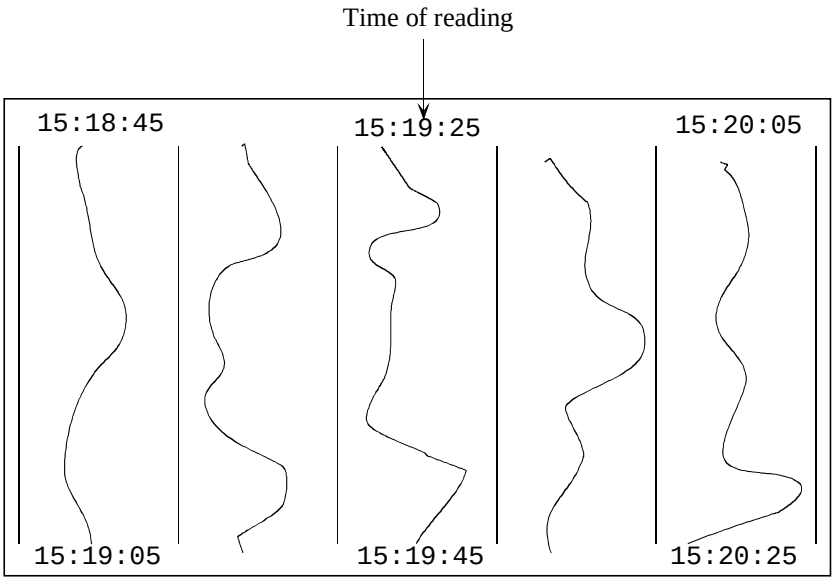


Chart Display for Base Station

The chart display shows profiles of 5 lines of data at a time. The vertical position of the display window is shown on the upper and lower left of the display. The upper right corner shows the x and y position of the cursor.

Data Review Menu

Pressing the MENU key brings up the data review menu

```
                DATA REVIEW MENU


          Move to position
               Line:    [    6    ]
               Mark:    [    0    ]


         Full Scale:   <   50    >    nT


         Zoom to show <  ALL   > of line
```

Data Review Menu

The data review menu allow you to go directly to a desired position to view the data without tediously scrolling with the arrow keys. You may also change the horizontal scale, or the vertical scale.

Move to position

You may enter the Line and Mark numbers you which to jump the cursor to in these numeric entry fields. Don't forget to press the Enter key after entering the number.

Full Scale

This shows the horizontal full scale, in nano Teslas of each profile column. The data line will "wrap around" to stay within the window. In other words, if the data line moves off the right side of the column, it will reappear at the left side of the column if the field increases slightly.

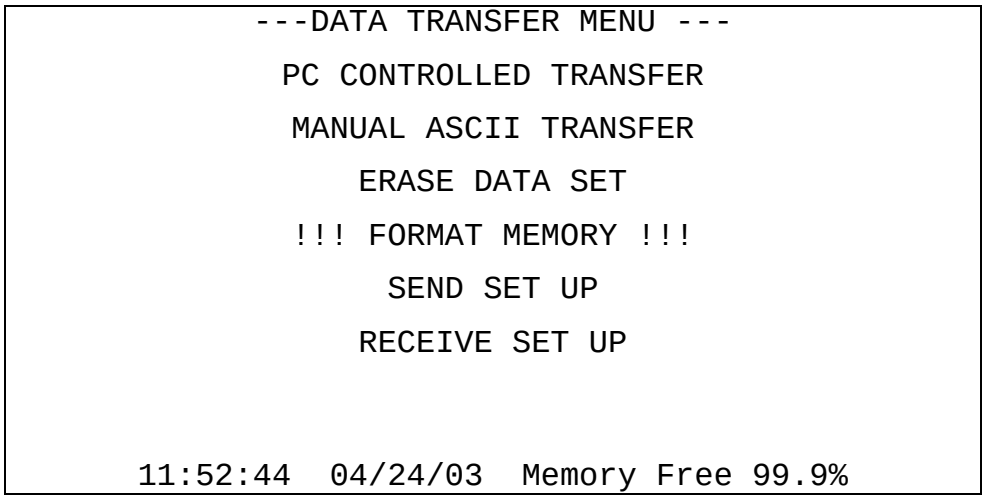
Zoom

This field sets the vertical scale of the display. You may show all of the line, or portions of a line by scrolling through this scroll box with the left and right arrow keys.

If the vertical scale include only a portion of the entire line, you may scroll up the display by moving the cursor with the arrow keys.

Chapter 9: Data Transfer

Selecting DATA TRANSFER from the Main Menu will bring up the data transfer menu:



Data Transfer Menu

This menu allows you to transfer data in either binary form or ASCII form. ASCII data is human readable, but takes about 100 times as long to download. It is suitable only for the smallest files.

Attach the serial cable (supplied with the unit) to the serial port. The other end connects to your PC. Some computers may require a 9 pin to 25 pin serial adapter, available from your computer store. You will need to know which serial port (typically COM1 or COM2) you have attached it to.

PC Controlled Transfer

Allows transfer of data in binary format. Data will be downloaded under the control of the MagMap2000 program on your PC. You must select this option on the G-859 console, then select download from the MagMap2000 program. See Chapter 11, for details on running MagMap2000. You will also need to know which file number you want to transfer. You may select MANUAL ASCII TRANSFER to page through the files to see which one you want to transfer. Then press ESC to return to this menu, then select PC CONTROLLED TRANSFER.

Manual ASCII Transfer

This allows data to be transferred in ASCII format. See the section below for the sub-menus under this option.

Erase Data Set

This allows a particular data set (file) to be erased. See the section below for details.

PC Controlled Transfer

Select this option, then run the MagMap2000 software. There, under the Import item of the main menu, you will find options for downloading data. See chapter 11 for more details on running MagMap2000.

Manual Ascii Transfer

Selecting Manual ASCII TRANSFER will bring up the following menu

```
        ---MANUAL ASCII TRANSFER MENU

   File < 1 >   MAG  MAPPED SURVEY

                 Start          End
     Time       01:38:45       02:40:34
     Date       03/03/95       03/03/95
       X          0.00           100.00
       Y          0.00           100.00
     File Size:  471   Readings:   115

          Baud Rate  <     9600   >

                START TRANSFER

     11:52:44  04/24/03  Memory Free 99.9%
```

You may scroll through the file numbers to the desired data set. Then select the baud rate. Next, you must set up your communications program on your PC. When you highlight START TRANSFER and press Enter, data will be sent out the serial port.

Erasing a Data Set

Selecting ERASE DATA SET will bring up the following menu

```
            ---ERASE DATA MENU---

   File < 1 >  MAG  MAPPED SURVEY

                 Start          End
     Time       01:38:45       02:40:34
     Date       03/03/95       03/03/95
       X          0.00           100.00
       Y          0.00           100.00
     File Size:  471   Readings:   115

      !!! DATA SET NOT TRANSFERRED  !!!

              DELETE THIS DATA

     11:52:44  04/24/03  Memory Free 99.9%
```

Scroll to the desired file number. Then select DELETE THIS DATA. You will be prompted with a dialog box before the file is actually erased. You will not be able to recover any file that you have deleted. Notice the warning message on the menu above for file numbers that have not been transferred. If you have transferred data from this file, this message will not be shown.

Format Memory

Erases the entire data memory of the G-859. All data in all files will be lost. If the system hangs up at some point, you may need to do this after power up to get the unit to behave properly.

Send Set Up

Intended for Geometrics Service and Test.

Receive Set Up

Intended for Geometrics Service and Test.

Chapter 10: GPS Programming

Overview

The G-859 is designed to simultaneously acquire GPS positions while it is acquiring magnetic data. The NovAtel Smart Antenna GPS is preset at the Geometrics factory to send the smallest possible $GPGGA position and time string in order to maximize memory utilization. The magnetometer interface for logging the GPS position data is also preset, and so the only requirements are that the user start the survey in either Simple Survey or Mapped Survey mode and the GPS information will be automatically logged. The console is set up so that the GPS is not logged when in Pause or at the End-of-Line. Again this is to maximize memory space.

The G-859 may be programmed to send commands to the GPS receiver when certain keys are pressed. All communication with the GPS takes place through the RS-232 port.

Note: Please remember that ASCII strings coming from a GPS unit take up a lot of memory space. Select the smallest data format you can for maximum data collection time. With a GPS unit sending a data string every 1 second in NMEA GGA format, for example, and the G-859 set to collect 10 readings per second, the memory will be full after about 3.5 hours.

Collecting GPS Data

Most G-859 magnetometers are equipped with a Novatel Smart Antenna GPS mounted on a backpack frame. These GPS units are cabled to the G-859 logging console and pack frame battery box. All necessary wiring connections are in the power cable supplied with the battery box. The Smart Antenna is pre-configured by Geometrics to provide the $GPGGA NMEA sentence only.

Make sure that the RS-232 port is set to collect GPS data. This is done in the main System Setup menu. Set the RS-232 port to DATA LOGGER. In addition, you will probably want to set the unit to store GPS data only when in the acquire mode. This means it will store GPS data only when magnetometer data is being stored. Therefore, between lines or when in PAUSE mode, no GPS data will be stored. This will save memory, and typically you will not be interested in GPS data during those times.

There is no need to program the NovAtel Smart Antenna GPS unless the GPS memory has become corrupted and it has lost its programming. If that were to occur it could start sending improper GPS serial data. If so, we recommend the following procedure:

NovAtel Smart Antenna Setup Version 1.2

Required Equipment:

1. Windows 98 – XP PC with RS 232 Serial port
2. HyperTerminal software
3. Novatel L1 StarView software
4. P/N 25358-20 Geometrics adapter cable (supplied with every system) which connects to the GPS interface cable wired into G-859 Pack Frame

Procedure

1. Turn off the battery box GPS power switch.
2. Connect the 25358-20 cable between the GPS serial cable wired into the pack frame (disconnect the serial cable from the G-859 console) and a serial port on the computer.
3. Turn on the battery box GPS power switch
4. Start the StarView software.
5. Set communications to 8 data bits, No parity, 1 stop bit, and 9600 baud.
6. Set the GPS to start with NMEA $GPGGA at 1 second rate.
7. The Smart Antenna is capable of SBAS (WAAS) positioning. If this is desired and the satellites are available in your survey area you must perform this additional step. Select *tool settings* | *Deselect*| *SVs* from the main menu. To track SBAS (WAAS) satellites select SBAS SVs and click on the *Send* button. To track GPS satellites, select *GPS SVs* and click on the *Send* button again. Refer to the *Star View User Manual* for more information. By default, if you select WAAS SVs alone, the unit is only searching for satellite PRNs 120, 122, and 134. Select *Status* | WAAS from the window menu to see the number of valid SBAS messages that are being decoded for a specific SV number since the last power-up. When the *Valid Messages* count is not incrementing, either the receiver is not tracking any SBAS satellites, or it's unable to read the SBAS data. If you have any trouble with your Smart Antenna, please contact NovAtel Customer Service at Email: support@novatel.ca, or by telephone at 403-295-4900.
8. Stop the StarView software.
9. Turn off the battery box GPS power switch.
10. Start Windows HyperTerminal™ and connect to the selected COM port at 9600 baud, 8 data bits, 1 stop bit, No parity, and No flow control.
11. Turn on the battery box GPS power switch.
12. Observe correct $GPGGA data.
13. Disconnect the P/N 25358-20 adapter cable and reconnect the GPS serial cable to the G-859 console.

Interfacing with User Supplied GPS Receivers

The RS-232 port of the G-859 is extremely versatile. The set-up procedure for RS-232 communication is sometimes complex, meaning that you will need to carefully study this section and

experiment to get user supplied (non-Novatel SmartAntenna™) external GPS equipment to work with the G-859.

Before connecting your GPS to the G-859, please make sure you completely understand how to operate the GPS system. GPS receivers will send data out in many formats, and you must know what commands will tell it to give you the data you wish. You may then program the G-859 to send these commands to the GPS receiver.

The next step is to program the commands needed by the GPS unit into the G-859. This is done by selecting EXT RS-232 & FIELD NOTE SETUP from the main System Setup menu. See the section earlier in this chapter for information on programming keystrokes to send commands to the GPS.

You will need to connect the GPS to the G-859 using the proper serial cable. Most GPS units will require a null-modem adapter between the supplied RS-232 cable for the G-859 and the GPS port. Contact Geometrics for the availability of a cable specially designed for connecting directly to a GPS system.

Once the GPS system is connected, you will need to actually send it the commands you have previously programmed into the G-859. This is most easily done in the CHAT MODE of the EXT RS-232 & FIELD NOTE SETUP. Select CHAT MODE, then press the desired keys to send the associated command. You will be able to observe the response of the GPS system from within chat mode. Make sure it is operating properly.

Now you are ready to log GPS data. Start your desired survey as usual. You will notice a bar indicator which when moving indicates that data is coming in on the RS-232 port.

Using GPS data

The GPS data stored during a survey is embedded within the magnetometer and other positioning data. You should upload this data into MagMap2000 where you can filter and plot GPS positions, magnetometer data, destripe (remove heading error), contour and plot the data. Interpolating the magnetometer data with GPS data is all done automatically and we recommend that you use the MagMap2000 program to position the data with GPS or UTM coordinates. Visit www.geometrics.com to download the latest version of MagMap2000.

If you want the GPS positions and time in a separate file, you must manually extract the GPS data from the magnetometer binary file. To manually extract the GPS positions from the file, perform the following procedure. First, download the binary file using the MagMap2000 program. If you wish, you can also do any other MagMap2000 function, such as locating the data or doing a diurnal correction. Remember the name of the binary file (.BIN extension) you used as the output file name when downloading the G-859 data (Import / Download). Exit the MagMap2000 program.

From the DOS prompt run the following program:

`BINTOASC` *`input`*`.bin` *`output`*`.gps -R0 -M0 -D0 -P0 -U0 -F0`

where

`input` is the name of the file containing the binary downloaded data (you must type the .BIN extension

`output` is the filename you wish for the GPS data (you must give it an extension. The `GPS` extension is a suggestion, however, you may use what you wish.)

`-R0 ...` The options tell the program not to extract everything except the RS-232 serial strings. They are a dash, a letter, and the numeral zero.

You will now have created a file of the GPS strings, along with some G-859 formatting information. Lines will be as shown below:

`21` *`DATA_STRING`* `Date Time`

Example (Line is broken only to fit on page. It is actually a single line in the file.)

```
21 $GPGGA,175748.00,3726.0363,N,12210.0318,W,0,6,001.1, 00024.6,M,-
028.4,M,031,0000*6C 10:59:14.80 06/01/95
```

The 21 at the beginning of the line indicates this string came in the RS-232 port of the G-859. The string is followed by a date and time stamp from the G-859. This may be used to correlate the positions with the magnetometer readings, which are also time stamped.

Chapter 11: System Setup

Selecting SYSTEM SETUP from the main menu brings up the following menu.

```
              ---SYSTEM SETUP MENU---
                      AUDIO
                   DATE & TIME
                  COM PORT SETUP
               COM & FIELD NOTE SETUP
                  MAGNETOMETER TEST
Real time transfer:      <  DISABLE  >
Use COM1 port as:
           <  ASCII CHARACTER LOGGER  >
                  <  CONFIGURE  >


Store serial data in:    < ACQUIRE MODE >
QC warning level:        [ 9.999   ] nT
```

System Setup Menu.

Audio

This allows you to set several parameters relating to the volumes and frequencies of the various audible tones. See below for more details.

Date & Time

Selecting this will allow you to set the date and time. See below for more details.

Com Port Setup

Selecting this will allow you to set the functions and baud rates of COM1 through COM4. This sets the baud rate of the serial for both incoming and outgoing data. Rates are selectable from 1200 to 115200. The system default is 9600. See below for more details.

Com & Field Note Setup

This allows you to define ASCII text strings to be either sent out the serial port or stored as field notes. Sending strings out the serial port is useful for controlling a GPS system. Field notes are useful to mark any desired event.

Each string is associated with a particular key press. During a survey, pressing the key will cause the associated string to be either stored as a field note, or sent out the RS-232 port as a command. See below for more details.

Magnetometer Test

This selection opens a screen that provides information about the state of operation of the Magnetometer. Also presented are a selection of internal volatages that indicate the state of the system. See below for more details.

Real Time Transfer

Enabling real time transfer will cause data to be sent out the serial port during the acquisition. The data coming out will be formatted exactly as for the ASCII data transfer. The setting will not affect whether or not data is stored inside the G-859. The options here are 'DISABLE' and 'ENABLE'. When EM-61 data is being acquired this should be set to 'DISABLE'. Sending data in real time to the EM-61 causes the EM-61 to report a huge[*] number of errors.

[*] huge = large enough to cause trouble. The G859 gets bogged down processing these error messages.

Serial Port (Use COM 1 as:)

There are several options for the use of COM 1 as follows:

SIMULATED KEYBOARD
ASCII CHARACTER LOGGER
GEOMETRICS MODULE LOGGER
FRAMED BINARY LOGGER
RAW BINARY LOGGER
EM-61 WITH MAGNETOMETER
EM-61 LOGGER

The "SIMULATED KEYBOARD" mode allows COM1 to appear as an external keyboard, in which case ASCII characters are interpreted as keypad presses. Using your favorite communication package on your PC, you can send key presses to the G-859. The built-in Microsoft Windows accessory Terminal works fine. See the section below **How to Download Commands from the PC.**

The "ASCII CHARACTER LOGGER" mode is used to log RS-232 strings are stored in memory as they come in through the COM 1 port. Up to three numbers from COM1 may also be displayed while acquiring data. The display of these numbers may be configured in the "CONFIGURE" line that appears below the " ASCII CHARACTER LOGGER" entry in the scroll list. None to three numbers may be selected and each number may be independently adjusted for bias, scale and 0 to 3 decimal places to display.

The "GEOMETRICS MODULE LOGGER" mode is used to log data from all products that comply with the "GEOMETRICS MODULE" format. These include the CM201, the CM221, the G880, the G881 and the OhmMapper. Readings from these can be used in place of the G859's sensors. The display of these numbers may be configured in the "CONFIGURE" line that appears below the "GEOMETRICS MODULE LOGGER " entry in the scroll list. Up to two numbers with decimal points may be detected and logged as magnetometer field values. Zero to three numbers may be selected and each number may be independently adjusted for bias, scale and 0 to 3 decimal places to display.

The "FRAMED BINARY LOGGER" mode is currently only used with the MineLabs EM system. The readings from this are used in place of the G859's sensors.

The "RAW BINARY LOGGER" mode would only be needed if what is being received is binary data of a format other than "FRAMED BINARY". Each received byte is simply converted into two hexidecimal digits "0..F" and stored.

The "EM-61 WITH MAGNETOMETER" mode allows an EM-61 to be connected and logged as ASCII while a magnetometer sensor is also connected. The odds of an EM-61 not interfering with the magnetics measurement are very near zero, but if it can be done, the G859 is ready for it. The EM-61's battery voltage will be displayed as described below. The logging of the EM-61 may be configured in the "CONFIGURE" line that appears below the "EM-61 WITH MAGNETOMETER" entry in the scroll list.

When cycling is set to "G859 timing", the EM-61 will be commanded to cycle by the G859. The command will be sent at the rate specified by the G859's cycle time setting.

The EM61 system has a built in encoder on one of its wheels. If you wish to use this you should select the "wheel encoder" option here. The cycle time setting of the G-859 will only serve as a time out time for receiving data from the EM-61. The EM-61 will send its data based on the rotation of the wheel.

The "manual button" mode is very like the "wheel encoder" mode. In this case the manual button on the EM-61 will cause a measurement.

After processing the EM-61's data to make a reading, you have three options of what to do with the string from the EM-61.

The "THROW AWAY THE REST" option means just that. The battery voltage and the "fine time" from the serial data will be discarded.

The "STORE THE REST AS SERIAL DATA" option causes a serial string consisting of only the battery voltage to be stored along with the "fine time" information.

The "STORE ENTIRE STRING AS SERIAL" option causes everything that came from the EM-61 to be stored as serial data as well as being stored in place of magnetics readings.

The "EM-61 LOGGER" mode allows the readings from the EM-61 system to be used in place of the magnetometer readings. Whenever the G859 is placed in any of the acquire modes (Search, Simple survey, Mapped survey) the battery voltage from the EM-61 will be displayed as a three digit number in the upper left part of the screen. . The logging of the EM-61 may be configured in the "CONFIGURE" line that appears below the " EM-61 LOGGER " entry in the scroll list. See the "CONFIGURE" line explanation just above.

Storing Serial Data (Store serial data:)

The storing of input ASCII text may be set to occur only when magnetic data is being recorded, "WHEN ACQUIRE" is selected (see the description of Acquire mode), or whenever the display is in the active state, "ALWAYS" selection (Acquire, Ready, or Pause modes). For a GPS system, you will typically be interested in collecting data during the Acquisition mode only.

Warning: Data will never be stored if the unit is displaying a menu, the map, or the data review profiles.

QC Warning Level:

This sets the level above which the QC will causes a warning tone to be sounded.

Audio Setup

There are several audible indicators on the G-859. Selecting AUDIO will bring up the following menu.

```
                AUDIO SETUP MENU

      Master Volume                 <  4  >
      Metronome Volume              <  4  >
      Metronome cadence (Beeps/min) [  60 ]
      Woowee volume                 <  4  >
      Woowee sensitivity            <  4  >
      Warning volume                <  4  >
      QC warning volume             <  4  >
      Mark/line key event volume    <  4  >
```

Master Volume

This field adjusts the level of all the sounds. 0 is the quietest, 9 the loudest.

Metronome Volume

This adjust the volume of the metronome. This metronome may be set to help you maintain a steady pace when surveying a site. 0 is the quietest, 9 the loudest.

Metronome cadence

This adjust the frequency of the metronome pace.

Woowee volume

The "woowee' is the audible indicator of field strength. It is particularly helpful when searching for anomalies in Search Mode. This sound is active only in continuous survey mode.

Woowee sensitivity

The frequency of the woowee noise changes with changing field strength. This number represents the amount of frequency change per increment in field strength. If the field is fairly smoothly varying, set this to a higher number. For fields with large variations, set to a smaller number.

Warning volume

This sets the volume for warning tones.

QC warning volume

This sets the volume of the QC warning tone.

Mark/line key event volume

This sets the volume of the key click noise when you press a position key

Setting the Date and Time

Selecting DATE & TIME form the System Setup Menu will bring up the following display.

```
              DATE AND TIME MENU

                    Date
                Month:   [ 2  ]
                Day:     [ 2  ]
                Year:    [ 95 ]


                    Time
                Hour:    [ 13 ]
                Minute:  [ 30 ]
                Second:  [ 00 ]

              SET TO ABOVE VALUES


              12:01:12   02/22/95
```

Date and Time Menu.

Enter the correct values in the numeric entry fields. Don't forget to press Enter after entering the value. Then highlight SET TO ABOVE VALUES and press Enter.

COM Port Setup Menu

Selecting COM PORT SETUP from the System Setup Menu will display the following menu:

```
         ---COM PORT SETUP MENU---
COM1 and COM4 PORT MODE: < 1 >
   COM1 is RS232 I/O
   COM4 is RS232 input
COM2 and COM3 PORT MODE: < 1 >
   COM2 is RS232 I/O
   COM3 is RS232 I/O
COM1 baud rate:     < 9600 >
COM2 baud rate:     < 9600 >
COM3 baud rate:     < 9600 >
COM4 baud rate:     < 9600 >
```

COM1 and COM4 Port Mode:

Mode 1 is COM1 is RS-232 I/O and COM4 is RS-232 input.
Mode 2 is COM1 is RS-232 I/O and COM4 is pulsed input.
Mode 3 is COM1 is RS422 input and COM4 disabled.

COM2 and COM3 Port Mode:

Mode 1 is COM2 is RS-232 I/O and COM3 is RS-232 I/O.
Mode 2 is COM2 is RS422 input and COM3 is disabled.

COM(x) baud rate:

The selections available for baud rates are:

1200

2400
4800
9600
19200
15200

The factory default is 9600.

External RS-232 and Field Note Setup

Selecting this item will bring up the following menu:

```
      --- EXT RS-232 & FIELD NOTE SETUP ---

    Assign key <  0     >  To  < RS-232 CMD    >
                DELETE COMMAND
          DOWNLOAD ALL COMMANDS FROM PC
                   CHAT MODE

    Press Mark to add current char to cmd
    Press Del to remove last char from cmd
    Press Map to add a comma to cmd
    Press Mumeric key to add digit to end

              Current Char  <  !  >

           Current Command/Field note:

   ----------------------------------------

   ----------------------------------------
```

Assign Key Field

This scroll list sets which key press is associated with the ASCII string.

Function Field

This scroll list sets up the key as either a RS-232 Command or a Field Note. RS-232 commands are sent out the serial port, while field notes are stored in the internal memory.

Delete Command

Pressing ENTER on this field will delete the entire command from memory.

Download all commands from PC

You may download an ASCII file from your PC to set up the entire set of commands. This is strongly recommended, since entering them from the scroll list below is very tedious. See the section below on how to set up and transfer a file of commands from your PC.

Chat Mode

This will enable you to observe the ASCII text coming from whatever device is connected to the serial port.

Current Character

You may scroll through this list to the desired character to add to the present command. Pressing the MARK key will add it to the end of the command. As a handy shortcut, you may press any numeric key to add a numeric character. There is no way to insert characters in the middle of the command. This manner of entering a command is so tedious, we recommend using it only if you forgot to download a needed command when you were near a PC.

How to Download Commands from the PC

Use your favorite ASCII text editor (DOS Edit or Windows Notepad are easy and readily available) to create a file as shown below:

```
G859CMD,00,$PASHS,NME,SAT,A,ON
G859CMD,01,$PASHS,SPD,B,2
G859CMD,02,$PASHS,RTC,REM,B
G859CMD,03,$PASHS,RTC,BAS,A
G859CMD,04,$PASHS,RTC,TYP,9,1
G859CMD,05,$PASHS,NME,GGA,A,ON
G859TXT,06,Fell into a hole
G859TXT,07,Dropped the magnetometer
G859END
```

The first six lines set up RS-232 commands. The keyword G-859CMD determines this. The second field, the two digit number, specifies which key the command or note is associated with. The numbers 00 through 09 correspond to the number keys on the console. The other keys are as shown below:

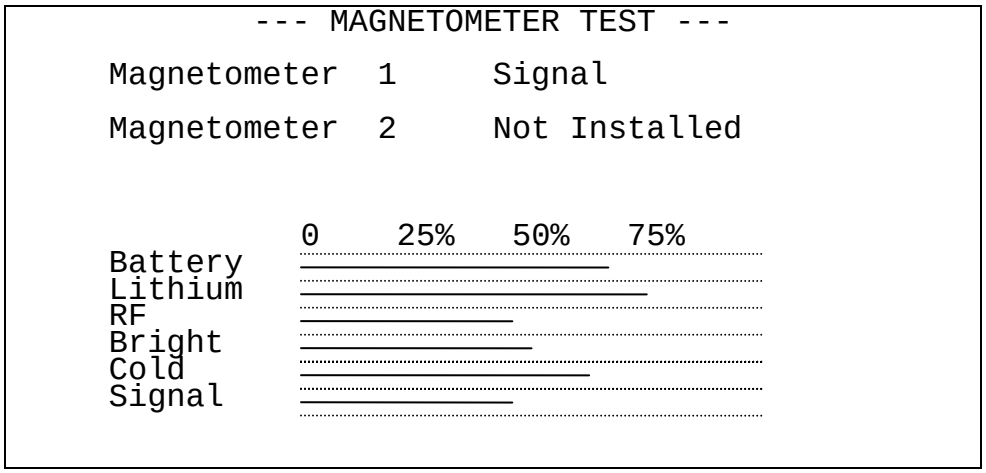
10	MARK	15	CHART
11	LINE	16	MAP
12	PAUSE	17	ENTER
13	ESC	18	POWER
14	MENU		

Note: The ASCII commands or field notes will only be active during the one of the active modes of operation. These are the Ready state, Acquire state, and Pause state, as explained on page 53.

Each key also retains its normal function. For example, if the MARK key is assigned to an RS-232 command, pressing it will still perform the normal MARK key function. This is useful, for example, if you wanted to store a GPS reading only at each MARK location. Then, you would program the MARK key with the command to query the GPS for the current position. In doing this, you would probably also want to program the END LINE key with the same command. Then, you will get a GPS confirmation at each fiducial point.

Magnetometer Test

The magnetometer test brings up the following display:



Magnetometer Test Display.

The first two lines, showing the status of the sensors, are very useful to watch if no signal is seen, and during system warm-up.. The possible states of the sensor are as follows:

Not installed. Indicates the sensor is unplugged.

Initializing. Checking for presence of sensor.

Warming Up. Sensor is being warmed up to the operating point. This may take several minutes in cold temperatures.

Starting Lamp. Energy is being applied to the sensor lamp to try to strike it. Should occur only briefly after sensor is warmed up.

Running up. Cesium cell is being warmed up to the desired temperature.

Regulating. Cell is operating, apparently normally, but a valid signal is not present. Usually occurs due to high field gradients, or the field being in a dead zone.

Signal. Sensor is reading a valid signal.

Failed. There was some problem in either striking the lamp or maintaining the desired brightness or temperature. Usually, unplugging the sensor and plugging it back in will eliminate the problem.

Next, the graph shows various internal voltages. A description of each item follows:

Battery: Indicates the voltage of the main battery. Full power is shown as 60%.

Lithium. Indicates the voltage of the internal lithium battery, which is responsible for storing data and setting when the unit is turned off. Normal operating range is 65% to 75%.

RF Indicates the drive level being applied to the cesium sensor lamps. Normal operating range is 25% to 75%.

Bright Indicates the resulting lamp brightness. Should be maintained at 50%. During warm up, this voltage will slowly settle at that value.

Cold Indicates the cesium cell temperature. Should be maintained near 50%. Larger numbers mean cooler cells.

Signal. Indicates the signal strength. Signal strength is a funciton of cell orientation and field value. Normal strengths are between 5% and 25%.

Chapter 12: MagMap2000 Software

The MagMap2000 software program provides the G-859 user with data downloading and editing capability. Acquired data is downloaded via high speed RS-232 communications link and then manipulated to generate or edit interpolated X-Y or GPS position information. A primary application included is the ability to apply diurnal correction from a base station. This requires secondary base station data file with overlapping date and time information.

Editing functions include shifting lines, changing the direction of lines, appending or cutting lines, deleting or inserting segments of lines or entire lines. Also included are data clean up routines including the ability to remove zero "drop outs", spikes and apply spline high pass or low pass filtering. The program offers a de-striping wizard (heading error correction) and has an interpolator wizard to enable construction of interpolated data files (can make a mag-GPS file from GPS-Time and Mag-Time files).

The resulting data can be plotted a profiles on the PC as a quality control measure and to assure coherence between the original acquisition parameters and the final locations. In addition the program provides simple gridding, contouring and plotting (printing) of the positions, track plots and magnetic contour maps. The data can be exported in formats compatible with Surfer for Windows (*.DAT) or Geosoft OASIS (*.XYZ).

Because of the power and complexity of the MagMap2000 program, its operation will not be covered here. Please refer to the MagMap2000 Manual (available on the Magnetometer CD shipped with the magnetometer system) for complete instructions on the use of the program. Also note that the MagMap2000 Manual, the MagMap2000 program and this manual are available on our web site www.geometrics.com under Downloads, FTP, PUB, MAG. We recommend that you regularly visit our site for the latest software upgrades.

Appendix 1: Surveying Principles

This section outlines the principles of performing a magnetic survey for anomaly location. It covers setting up, performing the survey and location of items of interest within the anomalous zones. Regional or geologic surveys for mineral exploration require a different set of procedures and are not covered in this overview. However, many of the guiding principles are identical and review of this section will be helpful.

Guidelines for Small Ground Magnetometer Surveys

The general comments below cover only the site layout and preparations for a survey. The survey objectives, determination of parameters for the instrument data collection and the actual data processing and map preparation are covered elsewhere.

In order to accomplish a successful ground survey magnetometer data acquisition, survey path over the ground and processing of the data into map form must be handled in a precise and accurate manner. Each element is completely interdependent upon the others and if one is compromised in quality or accuracy then all are compromised. During a survey, possibilities for error are numerous and great care and concentration are required to avoid mistakes, some of which may be so serious as to require starting the survey over. The focus should be on completing the survey completely error-free.

Typically, the most difficult surveys are those involving detection of small magnetic targets and the presentation of an accurate 1 or 2 nT contour map. In these cases, the survey must include: a close line spacing (1-2 m) with precise tracking in both the X- and Y- directions; diurnal correction (0.5 nT or better); correction of heading errors from instrument and/or operator; maintaining the sensor a constant distance above the ground; and absolutely no mistakes in procedure and data processing.

Number of People

Under certain conditions, the survey can be laid out and run by one individual; but this is rare and risky. It is far better to have a minimum of two people closely involved and ideally, three or even four people. Not only must the layout and marking of the survey lines be considered but also an individual must be designated to maintain a separate survey log, set up the base station, and operate the portable magnetometer. Note also that the operator doing all of the walking may require relief, for oftentimes the terrain and distance conspire to make his job very grueling.

Survey Efficiency

Speed and cost-efficiency in completing the survey is of course the ideal objective. This does not, however, require the use of innovative short cuts, new gadgetry or excessive manpower, but rather the avoidance of mistakes and errors. To prevent wondering off line even once in the course of a survey, with all of the attendant time spent sorting out and making the corrections, easily justifies a slower but more positive method. Efficiency will only be achieved by avoiding confusion, the correction of errors, and by the use of fail-safe procedures. All of the methods suggested below are simple low tech, and relatively slow, but proven effective. They can easily be improved upon but only at the risk of greater time, survey quality, or greater cost. So in the beginning, keep it as simple as possible.

Layout of the Survey Track

Having determined the optimum line spacing, layout the survey area in a square or rectangular format with the lines running N to S if possible. Use a Theodilite if available, otherwise use a measurement tape (non-stretch) of the required length. Designate one side of the area to be the "baseline" and layout and mark on this line each survey profile. Note that any stakes driven into the ground must be non-magnetic. (Wooden stakes driven into the ground will work well but may not be visible at distance.) If the site will be reoccupied in the future, it may be desirable to drive a one-meter iron rod (re-bar) into the ground at each corner of the survey area as a permanent marker. Since the profile line markers may not be visible at a distance, a method must be found that will allow the Magnetometer operator to locate and follow the line: a light cord or rope stretched on the ground between the beginning and end of each line; a long PVC pipe or other colored marker to be held at the end of each line and then sequentially moved; use of spray paint to mark a series of dashes along the path of each line, etc.

If the terrain is rough or bushy, ground markers along each line will be essential. Otherwise, if the terrain is flat and each end of the line is readily visible, a marker at each end and in the center may suffice. (The operator should have at least two markers to line up on when starting a line.) Whatever method is chosen, it must be completely non-magnetic, positive, easily moved in a coordinated way, and must give the operator a precise direction.

Note that coordination between the people moving the markers is sometimes difficult and frequently a source of error. In addition, if the survey lines are closely spaced, e.g., one- or two-meter separation, the Magnetometer operator may have trouble distinguishing between which marker to head for. The most certain and positive method in all cases is to mark the path by stretching a light string or rope the entire length of the pathway; or, to paint or otherwise mark the ground at short intervals.

If the area to be surveyed is larger than say 100 x 100 meters or difficult to walk through, then the area should be broken up into convenient sub-sections which overlap by at least one profile line. If some sections of line are not passable, then provision should be made for the operator to detour around them but only after establishing a procedure to stop/start (pause) and annotate the data. (This must be foolproof, simple and fully coordinated with the data processing.) Note that the Magnetometer operator must be aware of what line he is on at all times and the line number must agree with the line number recorded in the data. This is once again a frequent source of error and should be double-checked by another person.

In no case should a survey be started until all lines have been laid out and marked, and all aspects of the survey carefully re-checked. A few hours more or less at this stage means very little. What is crucial is to prevent major errors (or even minor ones) that may cost extra days of time and effort.

Diurnal Correction

There are many types of surveys that do not require correction for time varying field errors (diurnal). Generally they involve large magnetic targets such as pipelines and tanks, or coarse line spacing, or where the survey may be accomplished in a very short period of time. In these cases, once it is determined that a severe magnetic storm is not in progress, the survey can proceed without the normal base station correction and with good reliable results.

Note that the high measurement rate of the G-859 allows a rapid walking speed along the profile line. Thus, even large target anomalies are covered within tens of seconds, reducing the potential Diurnal effects.

Surveys that involve very close line spacing, small or subtle targets or where the maximum accuracy is desired require diurnal correction from a base station installed close to the survey area. Ideally, equal sensitivity and measurement rates to the field instrument should be employed in the base station. In general practice, whatever instrument is available is used. In most cases this works well even during periods of relative high field activity.

It should be remembered that "diurnal error" will have the same effects in the mapping process as "location error", and that without correction, low amplitude/high frequency anomalies could appear in the measured data that would seem to be targets but would in fact not be real. In addition, if the survey has been broken up into blocks that are acquired on different days, the blocks will not fit smoothly together unless a diurnal correction is made and their D C level shifted.

There are also other types of local magnetic field disturbances that can seriously effect the map accuracy and quality. These include ground currents and other local AC or DC fields from power lines or urban electric trains or trolleys. Of these, electric trains or trolleys are the more serious as their effects may be large in amplitude and extend for many miles. Usually it is more effective to complete the survey at night when these noise fields are greatly diminished.

Survey Accuracy

Commercial survey specifications may allow an “off line” error of up to ±20% (or more) of the line separation. For a magnetic object having an anomaly extending over several lines, this amount of location error does not prevent the object’s detection but does distort the anomaly’s shape, its peak-to-peak amplitude and its true location. Large changes in speed along the profile line will have a similar effect but can be prevented by the use of intermediate waypoints. (The worst case condition would be “off line” by +20% in one direction and "off line” by -20% in the opposite direction with each line having a 10% change in speed.) Location errors of this magnitude will not seriously change the overall correctness of the final map, considering that this type of survey is primarily for detection/location. This is not the case, however, if the location errors substantially exceed ±20%, e.g., off by one or more line separations. This amount of error may cause targets of interest to go undetected, or target anomalies to be shifted in location, resulting in, at worst, an erroneous map or at best an untrustworthy one. Careful layout and accurate tracking along the line will avoid these problems.

Survey Credibility

How does a client or survey manager know that a survey has been conducted properly and that the results are correct and believable? He examines the finished contour map for gross errors in data fit, location of target signatures, and overall map quality.

1) Selected anomalies that have been detected are re-acquired to see if they are in the proper location.
2) The raw data are examined to insure that line numbers are correct, data corrections have been properly executed, etc.
3) Selected tests are made on the finished data, e.g., a plot of “stacked profiles” to determine that start/stop points are correct, speed changes are not excessive, there are no data gaps, etc.

Location of Small Objects within Associated Anomalies

When data has been acquired over an area and processed into map form, it is often necessary to reacquire the location of each anomaly and dig to expose the ferrous object. The relocation of the anomaly is relatively simple since the coordinates can be taken directly from the map produced. However, the exact location of the object within the anomaly is often times difficult to identify and the convoluted magnetic field can be very confusing.

The anomaly may be sharp and steep (high frequency) indicating a small object close to the surface. It may be just one peak or it may be multiple peaks depending upon the object's shape, its orientation within the earth's field, and whether the anomaly is largely due to permanent or induced effect. It may appear as a dipole or monopole, and its shape on the map may be further distorted by the distance between profiles, especially if this is large with respect to the object size. Each of these factors will also affect the anomaly signature when the object is much larger in ferrous mass and/or is buried much deeper with the resultant areal coverage of the anomaly much larger (low frequency).

As one sweeps the G-859 sensor over these peaks, it is difficult to conceptually grasp their significance, especially when using the audio output as a reference. To reduce confusion and to provide the basis for a systematic approach, it is very helpful to produce a 3-D map showing each of the peaks and valleys with the perspective of depth. Generally, a high and low pair (monopole) will stand out from the rest of the peaks and if these peaks are relocated using the G-859, the object will be midway between them.

When undertaking this exercise in the field, the audio tone should be turned down or even disregarded with the visual display of the earth's field on the front panel becoming the primary focus. By slowly moving the sensor over the anomalous area, the exact high and low peak can be located and a spot on the ground marked for each. A dipole, in the earth's field inclinations of greater than 60° will have its low North of the high peak, and in horizontal fields (inclination of 0°), the low will be in the center with a high at the North and the South ends. The point midway between high and low will contain the highest gradient and will be directly over the object or very close to it. In those cases where there is only one strong peak, the object will be directly beneath the peak.

For very large anomalies the distance between high and low peaks may be two to ten meters or even greater. To reduce the amount of digging, it is suggested that a short profile be run completely over the anomaly, passing directly over each peak previously located and marked on the ground. Viewing this profile on the G-859 display will allow the estimation of the point of inflection of the curve between the peaks indicating the point of maximum Gradient (which should be directly over the object), and the depth of burial by means of the half width rule. (Refer to chapter V of Applications Manual for Portable Magnetometers.)

Appendix 2: CSAZ

Cesium Sensor Azimuth Program

CSAZ is a program written by Geometrics for users of Cesium magnetometers. The purpose of the program is to determine the proper orientation of the Cesium sensor at various Earth field dip angles (field inclination). AZ stands for azimuth or inclination.

The program is located on the MagMap2000 install disk included with the G-859. Once MagMap2000 is installed, CSAZ will also be installed.

A newly designed CSAZII program is available from our FTP site at

ftp://geom.geometrics.com/pub/mag/Software/csaz2-setup.exe

Please read the manual that is included with the program for complete instructions on how to use the CSAZII program for sensor orientation solutions at various locations on the globe. Note that you should use the “generic” CSAZ mode for G-859 solutions.

Appendix 3: Advanced Information

This information is supplied for those interested in some of the more technical aspects of the G-859. Look in this chapter for some answers to frequently-asked-questions.

Memory Usage

Inside the G-859, readings and positions (Marks and Lines) are simply stored sequentially, with a time stamp. The MagMap2000 program will put the first reading following a mark exactly at that mark. The last reading before a Line event will be placed at that position.

Readings average about 3 bytes each, and positions about 10 bytes. GPS strings average about 30 bytes per reading. There is 1 Mbyte of memory in the standard unit, 2.5 MB in all units with the new CPU board that support 4 com ports. There is no limit to the memory used by each file.

Some memory is wasted by using additional files. Each new file must start on a 64K boundary. An average of 32K will be wasted, then, by opening each additional file.

File Formats

The following information is supplied for those users who wish to perform manipulations on the data beyond that which MagMap2000 is capable of. This section will explain the various file formats used in the data analysis process.

Binary File

This file has the `.BIN` extension, and is a raw dump of the data contained inside the memory of the G-859. This data is not stored in a user readable format. It is compressed in a manner unique to the requirements of the operation of the G-859. Furthermore, each new revision of the G-859 firmware may cause changes in this file format. Do not attempt to modify files of this type.

ASCII File

This file has the `.STN` extension, and is in a user-readable format. This file is created by the program `BINTOASC.EXE`. This program is run with the default parameters from the MagMap2000 program. It may also be run directly from the DOS prompt, and given many options which will adjust the format of the output. Please see the section later in this appendix describing the operation of `BINTOASC`.

The ASCII file contains lines which are a record of events from the perspective of the G-859. Events may be either magnetometer readings, MARK, END LINE, or PAUSE key presses, RS-232 input strings, or field notes. Each event is recorded in the order it was received, and given a time stamp.

Note: The ASCII file lists these events backwards in time, i.e., last-in-first-out.

Each line in the ASCII file starts with a number, referred to as the TYPE in the following discussion. The TYPE indicates what information follows. The table below shows the TYPE for each of the events.

TYPE	Event
0	Magnetometer Reading
3	Position Event
6	Discontinuity Event
9	PAUSE key press
12	UNPAUSE key press
21	RS-232 string

33	Field note

Positions events and discontinuities are caused by MARK or END LINE key presses. Typically, a discontinuity event is associated with the beginning of a line.

The C-program lines which `BINTOASC` uses to create these files are shown below.

TYPE 0: Magnetometer Readings

```
fprintf(pAscFile, "%-2u %10.3lf %10.3lf %.2d:%.2d:%.2d.%.2d
%.2d/%.2d/%2.d %3u\r\n",
       type,                   // 0 in this case
       reading1,               // reading from sensor 1 (front connector)
       reading2,               // reading from sensor 2 if connected
       hours,                  // time of day
       minutes,
       seconds,
       hundredths,
       month,                  // date
       day,
       year,
       status );               // G-859 internal information.
```

Example:

```
0   49881.953  49874.396 11:02:08.60 06/01/95   0
```

TYPE 3: Position events.

```
fprintf(pAscFile, "%-2u %12.2lf %12.2lf %.2d:%.2d:%.2d.%.2d
%.2d/%.2d/%2.d %10ld %11ld %11ld %3u\r\n",
       type,                   // 3 in this case
       x_position,             // X coordinate
       y_position,             // Y coordinate
       hours,                  // time of day
       minutes,
       seconds,
       hundredths,
       month,                  // date
       day,
       year,
       Number_of_Readings,     // Number of readings since last position or
                               //    discontinuity
       Line,                   // Line number
       Station,                // Mark Number
       Status );               // G-859 internal information.
```

Example: (some blanks omitted to fit onto a single line)

```
3       26.00       0.00 11:02:08.70 06/01/95      168       13      0   5
```

TYPE 6: Discontinuity events.

```
fprintf(pAscFile, "%-2u %12.2lf %12.2lf %.2d:%.2d:%.2d.%.2d
%.2d/%.2d/%2.d %10ld %11ld %11ld %3u %10ld\r\n",
       type,                   // 6 in this case
       x_position,             // X coordinate
       y_position,             // Y coordinate
       hours,                  // time of day
       minutes,
       seconds,
       hundredths,
       month,                  // date
       day,
       year,
       Number_of_Readings,     // Number of readings since last position
       Line,                   // Line number
       Station,                // Mark Number
       Status,                 // G-859 internal information.
       Positions );            // Number of positions since last discontinuity
```

Example: (some blanks omitted to fit onto a single line)

```
6       26.00       0.00 11:02:08.70 06/01/95      168       13      0   5   3
```

TYPE 9: Pause event

```
fprintf(pAscFile, "%-2u %.2d:%.2d:%.2d.%.2d %.2d/%.2d/%2.d\r\n",
       type,                   // 9 in this case
       hours,                  // time of day
       minutes,
       seconds,
       hundredths,
       month,                  // date
       day,
       year ) ;
```

Example:

```
9  18:49:44.90 05/31/95
```

TYPE 12: Unpause event

```
fprintf(pAscFile, "%-2u %.2d:%.2d:%.2d.%.2d %.2d/%.2d/%2.d\r\n",
       type,                   // 12 in this case
       hours,                  // time of day
       minutes,
       seconds,
       hundredths,
       month,                  // date
       day,
       year ) ;
```

Example:

```
12 18:49:44.90 05/31/95
```

TYPE 21: RS-232 event

```
fprintf(pAscFile, "%-2u %s %.2d:%.2d:%.2d.%.2d %.2d/%.2d/%2.2d /4d%
/1d%\r\n",
       type,                   // 21 in this case
       input_string,           // ASCII string received from RS-232
       hours,                  // time of day
       minutes,
       seconds,
       hundredths,
       month,                  // date
       day,
       year
       fine time               //increments of 0.25ms, set to zero every
                               0.1sec
       com ) ;                 //com port from which this data string is
                               received, 0=COM1, 1=COM2, etc.
```

Example:

```
21 $GPGGA,015009.00,3725.9975,N,12209.9992,W,2,4,002.5,00025.1,M,-
028.4,M,001,0000*65 18:49:44.90 05/31/95 0.25 0
```

TYPE 33: Field note

```
fprintf(pAscFile, "%-2u %s %.2d:%.2d:%.2d.%.2d %.2d/%.2d/%2.d\r\n",
       type,                   // 33 in this case
       input_string,           // ASCII string received from RS-232
       hours,                  // time of day
       minutes,
       seconds,
       hundredths,
       month,                  // date
       day,
       year ) ;
```

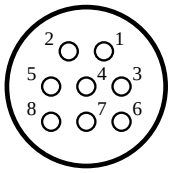
Example:

```
33 Fell down 18:49:44.90 05/31/95
```

I/O Connector Pinout

There are 3 inputs on the I/O connector which simulate END LINE, MARK and ENTER key presses. Momentarily connecting the corresponding pin to pin 4 is equivalent to pressing the key on the keypad:

I/O connector on console:

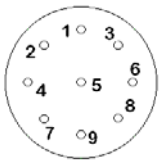


Pin Number	Function
1	Ground
2	RS-232 Receive
3	RS-232 Transmit
4	Ground
5	Mark
6	Audio
7	Line
8	Enter

Power Connector Pinout

If more that COM1 serial port is to be logged, COM2, COM3 and COM4 are presented on the Power Connector.

Power Connector on console:



Pin Number	Function
1	+28V
2	+28V
3	COM4-RXD
4	COM3-RXD
5	COM2-RXD
6	COM3-TXD
7	COM2-TXD
8	GROUND
9	GROUND

Some care needs to be exercised in the design of the external cables. The G859's COM1 connector's ground pin is internally connected to the ground on the power connector. If the external cables also connect COM1 connector's ground to the power connectors ground, a loop will result. This loop will appear asa shorted turn of copper wire to the EM-61. Depending on the cross section of this loop

it may effect the data from the EM-61. Also, if a substantial part of the G859's battery current finds its return path through the COM1 cable, a magnetic field will be produced. This magnetic field could effect the data when the G859 is working as a magnetometer.

We have found that building a 100 ohm resistor into the return wire of the COM1 RS-232 cable prevents such problems. Simply omitting the return connection in the COM1 cable will also work, but this can cause confusion when the system is being tested, because two cables must be connected before the COM1 RS-232 connections are complete.

Field Notes

You may extract the field notes into a file in much the same manner as extracting GPS data (se Chapter 9). This is done by using the BINTOASC program with options to tell it to only extract the field notes.

Type the following line at the command prompt:

```
BINTOASC input.bin output.txt -R0 -M0 -D0 -P0 -U0 -S0
```

where

input is the name of the file containing the binary downloaded data (you must type the .BIN extension

output is the filename you wish for the GPS data (you must give it an extension. The TXT extension is a suggestion, however, you may use what you wish.)

-R0 ... The options tell the program not to extract everything except the field notes. They are a dash, a letter, and the numeral zero.

You will now have created a file of the field notes, along with some G-859 formatting information. Lines will be as shown below:

```
33 Fell into a hole 10:59:14.80 06/01/95
33 Ran into a tree 11:16:25.40 06/01/95
33 Fell into a hole 12:01:36.80 06/01/95
```

Please contact Geometrics for information regarding availability of programs which automate usage of these features.

EM-61 Data

The data from the Geonics EM-61 consists of two numbers and a gain code. The new G859 software allows this data to be taken from the COM1 serial port and used in place of the magnetometer readings.

Since the numbers from the EM-61 can be both positive and negative, but the G859 software was designed for magnetic fields, which can never be negative, the EM-61 values are adjusted to make them appear in the normal range of magnetic readings. To do this, the numbers are corrected for the gain code, multiplied by 4/125 and then added to 50000.

The readings will span:

50000 - 15.000 * 32768 * 4/125 = 34271.36
50000 + 15.000 * 32767 * 4/125 = 65728.16

To convert these back to normal EM-61 values you simply calculate:

$Y = 4(X-50000)/125$

Where:
X is the reported value in nT
Y is the correct EM-61 value

MagMap2000 does not yet contain this calculation.

When using the G859 to log EM-61 data you may notice that the displayed numbers move in a more stepwise manner than it does when recording magnetic fields. This is normal. The EM-61 reports a 16 bit integer for its reading. When these are multiplied by the correct factors for each of the gains this causes the resulting values to move in increments as shown below.

15.0000 * 4/125 = 0.480
0.7500 * 4/125 = 0.024
3.7500 * 4/125 = 0.120
0.1875 * 4/125 = 0.006

SYSTEM SPECIFICATIONS

MAGNETOMETER / ELECTRONICS

Operating Principle: Self-oscillating split-beam Cesium Vapor (non-radioactive CS-133).
Operating Range: 18,000 to 95,000 nT (γ)
Operating Zones: For highest signal-to-noise ratio, the sensor long axis should be oriented at 45°, ±30° to the earth's field angle, but operation will continue through 45°, ±35°. Sensor is automatic hemisphere switching.
Sensitivity: 90% of all readings will fall within the following P-P envelopes:
0.03 nT at 0.2 sec cycle rate (SX=0.113nT)
0.02 nT at 0.5 sec cycle rate (SX=0.072nT)
0.01 nT at 1.0 sec cycle rate (SX=0.051nT)
Information Bandwidth: < 0.004 nT (γ)/√Hz RMS
Heading Error: < ± 0.5 nT (γ)
Temperature Drift: 0.05 nT per degree C
Gradient Tolerance: > 500 nT (γ)/inch (>20,000 nT (γ)/meter
Cycle Rate: Variable from 0.2 sec to 1 hr in 0.1 sec steps or by external trigger.
Data Storage: Non-volatile RAM with capacity for 8 hrs of Magnetometer time, event marks, location as GPS at maximum sample rates.
Audio Output:
1. Audio tone of earth's field variation, pitch and volume adjustable. (Search)
2. Audio pulse each 1 second (Pace metronome).
3. Alarm for loss of signal, noise in signal (QC) or low battery.

Data I/O: RS-232 standard bidirectional serial port, selectable continuous real time data transmission via RS-232 to PC. Memory dump transfer time less than 5 min at 115Kbaud transmission rate.
Visual Output: Micro-controller driven, 320 x 200 graphic liquid-crystal display, daylight visible with selectable outputs for:
1. Data display: Up to 5 stacked profiles, real time or review mode. Map of survey grid with zoom functions.
2. All system set-up functions, e.g., memory status, data transfer, sample time.
3. All Survey set-up functions, e.g., survey profile number and direction, station or GPS number,
4. Survey monitoring functions, e.g. total field, noise level, profile number x or xy coordinates.

Internal Clock: Resolution of 0.1 sec, drift: < 1 sec/day
Power: 1. 24 VDC rechargeable gel cell, 6 hrs Magnetometer with GPS. Magnetic effect less than 1 nT (γ) at 3 ft.
2.Internal backup battery for clock and non-volatile RAM.
External power input 12 to 34 VDC, 1 amp on turn-on, 600ma operating in magnetometer mode.

Software: Supplied as part of the basic system for installation in the Geometrics or client-supplied PC, and including functions for:

Operating Software:
1. Survey Modes:
   a. Search
   b. Simple survey, station or continuous
   c. Map survey, station or continuous
   d. Base station
2. Data acquisition/display:
   a. Acquire and store data and survey functions.
   b. Display profiles, total field to 0.1 nT resolution,, survey/map parameters and diagnostics.
   C. Map display showing location of all readings.

PC Support Software:
1. Data transfer and corrections:
   a. Transfer of data from the field Magnetometer, GPS, or Base station to the PC.
   b. Diurnal correction using base station data.
   c. Processing the corrected data into ASCII values of X-Y-Z for the magnetometer
2. Optional bundled "Surfer for Windows" by Golden. Provides data presentation/plotting into a contour map or 3D isomagnetic map with Text annotation and color blends.

MECHANICAL

Sensor: 2-3/8" dia., 6-3/4" long, 12 ounces 6 cm x 15 cm, 340 g
Console: 6" W, 3" H, 11" L, 3.5 lbs. (15 cm x 8 cm x 28 cm, 1.6 kg), attaches to harness. Magnetic effect less than 1 nT (γ) at 3 ft
Battery: 3" H, 5" W, 8" L, 3.5 lbs (8 cm x 13 cm x 20 cm, 1.6 kg) attaches to harness.
Backpack specs ?

ENVIRONMENTAL

Operating Temperature: -15°C to +50°C (-13°F to + 122°F)
Storage Temperature: -35°C to + 60°C (-30°F to + 140°F)
Water Tight: To 1 ft (0.3 m) depth for 10 seconds.
Shock: Drop 3 ft on a hard surface without damage

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